INTERMITTENT-FAULT FINDER

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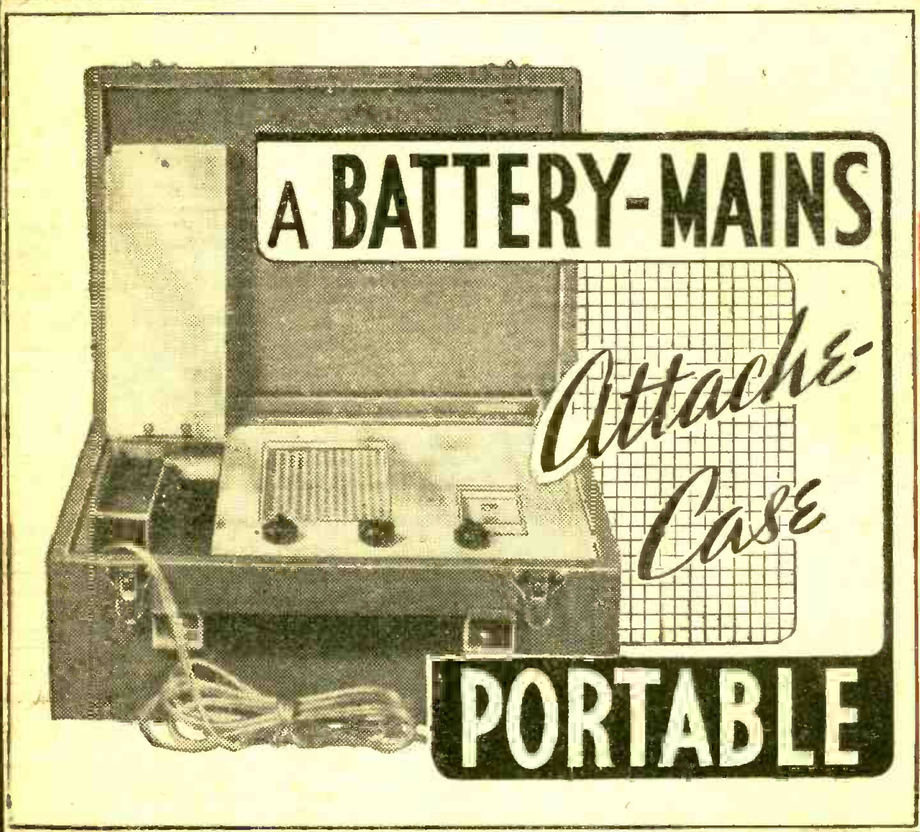
EDITOR:
F.J. CAMM

PRACTICAL WIRELESS



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Practical Wireless

EVERY MONTH
VOL. XXIX, No. 555 JANUARY, 1953

Editor F. J. CAMM

21st YEAR OF ISSUE

COMMENTS OF THE MONTH

By THE EDITOR

Radio and TV Sales

FIGURES recently published relating to the relative sales of radio and television receivers encourage the thought that the final figures for 1952 will be an improvement on the first half of the year. Sales were at their lowest in June for both radio and television, but since then television sales have shown a marked improvement, and have risen from an average of 5.29 sets per shop in August to 10.28 in September, and this is considerably above that recorded for 1951.

Although the sales of radio receivers have climbed more slowly and, at the moment of going to press, are still below the level for the same period last year, there are unmistakable signs that trade is improving. The new hire purchase terms, and the thought that perhaps purchase tax might be reduced, were responsible for the public ceasing to buy. There is little possibility of purchase tax being removed until the next Budget in April.

We are also able to report a continued growth in the demand for home-constructed receivers, and our plans for 1953 are well advanced. We shall produce a special receiver to celebrate Coronation year and many others are on the way as the result of suggestions which readers have made. The trade has promised to support us by producing in adequate quantities components to our specification, and this will remove one of the chief complaints of readers : that they are unable to obtain components as specified on some of our blueprints. Wherever possible we are glad to suggest alternatives.

We also propose to introduce a regular monthly feature under the title of " A Beginner's Guide to Radio," specially designed to appeal to those who are taking up radio for the first time. It will also act as a refresher course to those who have dropped the hobby but are renewing acquaintance with it.

Readers will be able to learn as they build, and every part of a receiver will be carefully explained in detail. We shall not adopt the usual practice of dealing with Ohm's Law in the first part. That will be explained when the beginner has built a simple receiver to our instructions so that he has some apparatus by means of which to prove Ohm's Law. We hope to include the first of this series next month.

INDEXES FOR VOLUME 28

THE Title Page and Index for Volume 28 is now available at 1s. 1d. by post. Readers are urged to obtain a copy of this whether they have their copies bound or not, as it saves both them and us considerable time. The reader is able to turn up an article which has already appeared, or to ascertain whether such information has appeared, and we are saved the time of repeating information given so many times before.

THE CHURCH AND SPONSORED PROGRAMMES

ELSEWHERE in this issue a contributor raises the question of whether it should be any concern of the Church that sponsored programmes on TV are likely to be radiated in the near future, as recommended in the Beveridge Report. The whole question of sponsored programmes is debatable and it is doubtful whether the country as a whole really requires it ; but this is not because of the reason advanced by Dr. Garbett, who paints an altogether lugubrious picture of sponsored broadcasting and sponsored TV programmes. We do not believe that sponsored radio, whether on sound or TV, is likely to have damaging effects upon the public mind any more than the cinema has done. The public are well aware, through the cinema, of many things which in primordial times were kept from them, and the Church must not presume that good living comes by ignorance of evil. On the other hand radio and television have had an enlightening and mind-broadening effect on the public, and education is more likely to result from entertainment than it is from sermons. We agree that safeguards must be applied, but the BBC, with that rigidity of control which it has exercised so well from the start, can be trusted to see that nothing contrary to public interests will be radiated. They have their own means of finding out what the public requires and public reactions to its programmes. These methods are far more precise than those possessed by the Church or any other body.—F.J.C.

ROUND the WORLD of WIRELESS

National Radio Show

THE Radio Industry Council has announced that provisional dates for the 20th National Radio Show, 1953, to be held at Earl's Court, London, are September 1st to 12th.

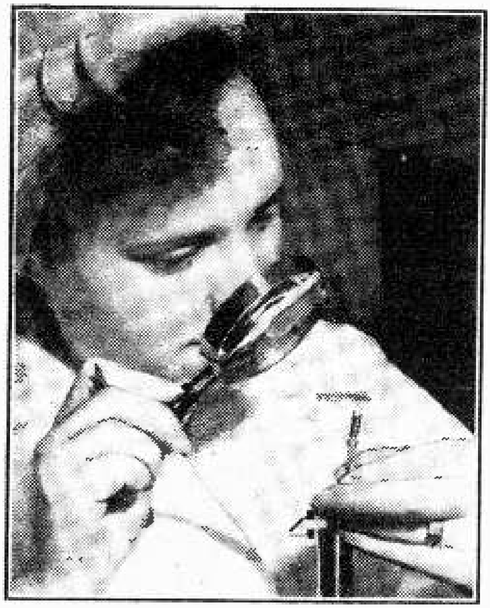
The dates are subject to confirmation.

B.I.R.E.

THE following Institution meetings will be held during December, 1952 :

London Section.—Wednesday, December 10th, at 6.30 p.m., London School of Hygiene and Tropical Medicine, Keppel Street (Gower Street), London, W.C.1 : "The Production of Television Receivers"—Frank Allen.

West Midlands Section.—Tuesday, December 9th, at 7.15 p.m., Wolverhampton and Staffordshire Technical College, Wulfruna Street, Wolverhampton : A Programme of Technical Films.



A magnifying glass is necessary to inspect the smallest radio valve of its class in the world. These tiny Mullard valves, three of which can be comfortably held in an ordinary household thimble, are specially designed for use in hearing aids.

North-Eastern Section.—Wednesday, December 10th, at 6 p.m., Institution of Mining and Mechanical Engineers, Neville Hall, Westgate Road, Newcastle-upon-Tyne : "The Development of the Radio and Electronics Industry in India"—G. D. Clifford.

Merseyside Section. — Thursday, December 18th, at 7 p.m., Electricity Service Centre, Whitechapel, Liverpool : Details may be obtained from the Honorary Secretary, J. Gledhill, 123, Portelet Road, Liverpool, 13.

A programme booklet giving details of the meetings of all sections of the Institution has been published. Copies may be obtained from the Publications Officer, Brit.I.R.E., 9, Bedford Square, London, W.C.1, price 4d., post free.

New Networks for South Africa

AN order worth a quarter of a million pounds—probably the largest number of high-power broadcasting transmitters in one order ever placed in Britain—has been awarded to Marconi's Wireless Telegraph Co., Ltd., through Marconi (South Africa), Ltd. It will give complete broadcasting coverage to the Union of South Africa, the network of nine 20 kW. high frequency transmitters being centred on one site.

The new system will be additional to the existing medium-frequency transmitters already serving part of the Union and the new transmitters will be installed at Paradys, near Bloemfontein.

These transmitters are the latest in high-frequency broadcasting design and all frequency changing can be controlled from a central point. Six of the transmitters will be used, in two groups of three, to cover the English, Afrikaans and commercial services on two alternative frequencies. Two will be used for the African service and the remaining transmitter will serve as a spare for all services.

H.R.H. The Duke of Edinburgh, K.G.

IT is announced from Buckingham Palace that His Royal Highness, the Duke of Edinburgh, K.G., has been very pleased to extend his Patronage to the Incorporated Radio Society of Great Britain.

Although His Royal Highness has lately undertaken a great number of additional responsibilities he will do his utmost to take a personal interest in the Society.

Apprenticeship Scheme

THE management of E. K. Cole, Ltd., have announced an extension to the existing apprenticeship scheme to cover an additional grade—that of Student Apprentice.

The object of this new scheme will be to provide a more general training than that available at present, which will fit the student apprentice for an appointment in the EKCO engineering works or office staff where there are considerable opportunities for advancement.

Student Apprenticeships will be open to present EKCO apprentices of 18 years and over with the necessary qualifications. A limited number of student apprenticeships will be available to outside applicants.

BBC Engineering Appointment

THE BBC announces the appointment of Mr. J. W. M. Swanson as Engineer-in-Charge, Newcastle.

Mr. Swanson joined the staff of the BBC in 1934 as an assistant maintenance engineer at the North Regional Transmitting

Station at Moorside Edge. He later served as a maintenance engineer at the Newcastle Studios and at the Tatsfield Receiving Station. In 1943 he became Assistant Engineer-in-Charge at the BBC's Monitoring Station at Caversham and held this post until his present appointment on October 20th, 1952.

Broadcast Receiving Licences

THE following statement shows the approximate number of sound licences issued during the year ended September, 1952. The grand total of sound and television licences was 12,843.595.

Region	Number
London Postal ...	1,811,336
Home Counties ...	1,513,304
Midland	1,402,362
North Eastern... ...	1,830,799
North Western ...	1,479,385
South Western ...	1,062,182
Welsh and Border ...	719,143
Total England and Wales	9,818,511
Scotland	1 156,311
Northern Ireland ...	213,327
Grand Total	11,188,149

Coming Radio Serials

FORTHCOMING radio serials include Charles Dickens' "Nicholas Nickleby," adapted and produced by Charles Lefeaux, which begins on Sunday, February 1st; R. L. Stevenson's "The Wrecker," produced by Cleland Finn, to be broadcast on December 7th, 14th and 21st, and "Ninety Three," by Victor Hugo, planned for the second quarter of 1953.

TV Sales Beat Radio

IN September, television receiver sales averaged 10.28 sets for each shop, the highest since February, 1952.

The average per shop for radio receivers was 6.85.

"Down Your Way"

THE last three venues for Richard Dimbleby's current "Down Your Way" programmes are Tredegar on December 7th, the Strand on December 14th, and Broadcasting House for the final "Looking Back" edition on December 21st.

Neal Arden

NEAL ARDEN, who again took on the role of disc jockey recently with a new series of "Quiet Rhythm" programmes on the Light, has been broadcasting regularly since 1934.

He was originally an optical student before going to South Africa and working first with B.S.A. and then as a farm implement salesman.

His first "Quiet Rhythm" series was launched in 1946.

Awards for Drama Students

DURING 1953 the BBC is to award two annual prizes of £25 each for proficiency and promise in the art of acting for the microphone. The prizes, which will include a six months' engagement with the BBC Drama Repertory Company, will be given to one student of each sex.

The first competition will be held at Broadcasting House, London, at the end of July, 1953, and the BBC is inviting drama schools which conduct regular instruction in microphone technique to an approved standard to submit the names of six final-year students (three of each sex) for these prizes.

The aim of these annual awards is to encourage the training of student actors and actresses in the special requirements of the microphone, and to discover and develop talent for sound broadcasting at an early stage.

Coronation Commentary

THE BBC has not yet decided on any particular commentator to cover the Coronation procession next June, although Richard Dimbleby has been named as a favourite for the honour of presenting the scene to sound listeners.

The Coronation of the late King George VI in 1937 was described by Howard Marshall.

Rediffusion Rejected

AFTER giving the idea a great deal of consideration, the Glasgow Planning Committee has rejected applications from two London firms to set up a radio and television rediffusion service in Glasgow.

"Tape-Deck"

WE are advised that the words "Tape-Deck" are the registered trade mark of Wright and Weaire, Ltd., and therefore the term can be only applied to the products of that company.

Pay Rise

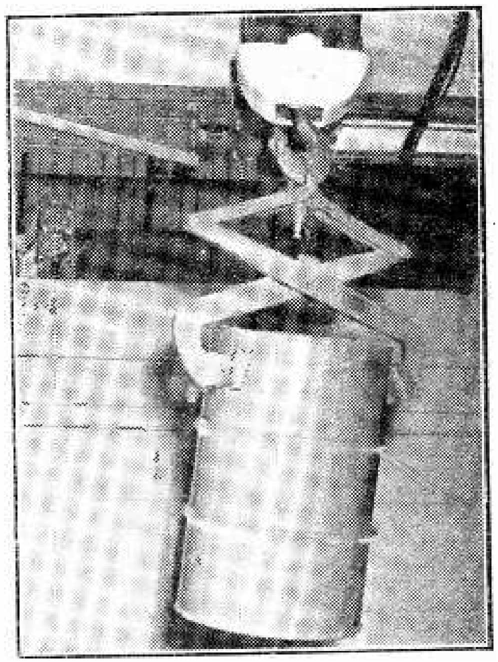
A PAY rise of 15 shillings a week has been awarded to radio service engineers by the Industrial Disputes Tribunal.

This raises their minimum rate of payment to £6 5s.

French-language Network

FOUR French-language radio stations are now in operation in Western Canada.

C.F.N.S., Saskatoon, Saskatchewan provide C.B.C. network programmes and local broadcasts to over 30,000 French-speaking inhabitants in the north of the province.



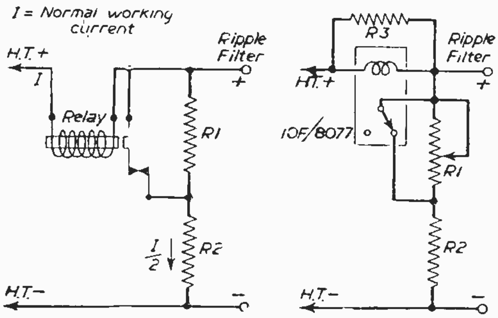
This radio-controlled crane is operated by an engineer using television, out of sight of the crane. The crane is seen picking up a load, and the Marconi television camera in the background.

PROTECTIVE CIRCUITS

DETAILS OF SOME USEFUL SURGE LIMITING ARRANGEMENTS

By M. C. Paul

IN the ever-growing field of commercial electricity as "prescribed" for the domestic consumer, there is a veritable wealth of appliances designed to protect him against his own misuse of this little understood medium of power. They range from "dry heat" fuses on kettles to motor overloads. It is well to consider this fact when constructing radio or electronic equipment and, by taking a leaf out of the electrical engineer's book, incorporate some form of protection for the device itself, and, where necessary, for the user of it.



Figs. 1 and 2.—Using a relay and an ex-service component.

Warming Time for Valves

When equipment comprising several valve stages is first energised little or no load current is drawn from the power supply, and H.T. line voltages invariably build up to a very high level, due to the absence of an effective shunt load across the reservoir condenser of the power pack. As the valves draw more current the shunt effect will increase and the H.T. line voltage fall until the working level of valve currents is reached.

To provide against component damage during this initial "warming up" period, filter condensers are selected so that their nominal working voltages approach twice the actual working figure, and/or some form of voltage limiting device is incorporated. The author has happened upon no "tailor-made" gadgets for this job, and has tried a variety of devices of his own inspiration, a few of which will be described.

Relay and Resistance

The device outlined in Fig. 1 should be incorporated between the usual ripple filter and the equipment used. The relay is of the medium resistance 3,000/600 type, and of some 200/1,000 Ω coil resistance. When de-energised it short-circuits R_1 when R_2 constitutes a shunt load from H.T.+ to earth. On switching the power pack on, very little current will be drawn by the equipment through the relay coil, and it will remain closed. R_2, however, is chosen so that its shunt current is about half that of the connected equipment under normal conditions, and it will prevent any undue voltage rise. The relay is chosen so that it operates on approximately two-thirds normal working current (equipment), when it will place R_1 in series with R_2 and its shunting effect will then be negligible, a few m/amps. if R_1 is made several times the value of R_2, and inefficient working is thus avoided.

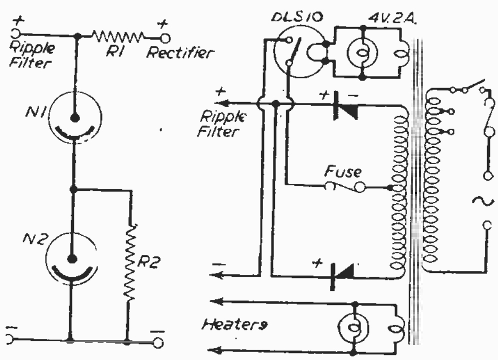
The author has deliberately refrained from specifying definite values for the components of Fig. 1, as they will vary widely with circuit requirements such as working voltages and currents. The relay must be capable of conducting the full working current with a margin of safety, and R_2 must be of an ample wattage rating. Some extra smoothing may be obtained if a 8-16 μF condenser is connected from the relay load side to chassis.

The Thermal Relay

An exactly similar function may be performed by the use of a thermal delay switch of suitable design. The heating element may be placed in the H.T.+ line and set so that its associated switch will be opened when two-thirds of the working current (equipment) is passing. Otherwise it replaces the magnetic relay of Fig. 1, R_1 and R_2 being evaluated as before.

In either device it is an advantage to make R_1 variable, as shown in Fig. 2, as undue switching surge can be limited with proper adjustment. In the original circuit an ex-Government 10F/8077 was utilised; this will operate at a minimum heater current of only 50 mA and incorporates a manual adjustment. Where really heavy H.T. line currents are required, it is useful to shunt the heater element with a suitable resistance, R_3. By varying R_3 the delay time may be controlled for any particular equipment.

The two devices described would work without R_1, but it has been found that it limits contact arcing in the relays, also the slight surge generated in merely switching R_2 out of circuit.



Figs. 3 and 5.—Neon stabilisers and another delayed circuit.

The Neon Stabiliser

The foregoing devices were essentially current operated. A more direct approach to the problem is to make direct use of the initial voltage rise. This can be done by using stabiliser type neon tubes, as in Fig. 3. There is nothing novel in the arrangement, it being an orthodox stabiliser circuit with that inherent advantage.

In choosing the neons some care must be exercised, and an example seems to be warranted, as much confusion exists on this subject.

Let us suppose that the H.T. line potential is 250 volts and the working current some 30 to 50 mA. The striking voltage of the Marconi Osram S130 is 135 volts and its maximum permissible current 75 mA. Thus two S130s in series, as shown in Fig. 3, would strike at 270 volts and be together capable of stabilising the supply. The resistance R_1 should be so chosen that it drops some 10 to 20 volts under normal working conditions, and under the conditions specified a 1,000 Ω resistor would make a good basis for experiment. If a slightly reduced stabilised line voltage results from the arrangement a small increase in the capacitance of the reservoir condenser will effect a remedy.

The chief disadvantage of this circuit is its bulkiness and cost, especially where really heavy current apparatus is to be stabilised. Under such conditions two or more tubes would have to be added if complete stabilisation was required. R_2 is included to prevent N_2 from being "starved" of potential and should be about 1 to 2 megohms.

Delayed H.T. Switching

Where a number of valve heaters are connected in series, as in A.C./D.C. heater chains, or directly and indirectly-heated valves are grouped together on a common H.T. supply, large voltage rises can initially occur due to "warming up" delay, and the uneven "warming up" periods of the second mixed heater group.

In the case of series heaters provision can be made for the inclusion in the "chain" of a thermal delay switch of the 10F/8077 type, where the internal switch is open at the cold position.

Such a unit may be utilised, as in Fig. 4, and is placed on the A.C. side of the rectifier. The heating element should be wired between the A.C. phase line and the ballast resistance, so that no large potential difference might occur between heater and contacts. Thermal delay tubes of the DLS1-DLS10 type are not suitable as their heaters require excessive current of 1 amp. or more.

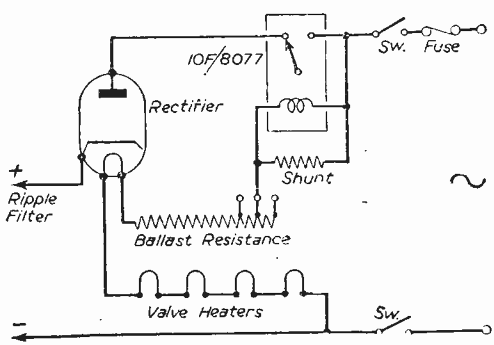


Fig. 4.—Delayed switching of H.T.

The delay time is determined fundamentally by the heater current, and may be adjusted by decreasing it, i.e., lengthening the delay time. This is best accomplished by placing a suitable wire-wound resistance across the heater, any further adjustment being made in the case of a 10F/8077 ; on the delay switch itself.

Where such a device is included in an existing piece of equipment some adjustment will have to be made to its ballast resistance and/or the omission of a pilot lamp. Thus keeping the overall chain resistance the same, or nearly so, a 5 per cent. increase may be tolerated.

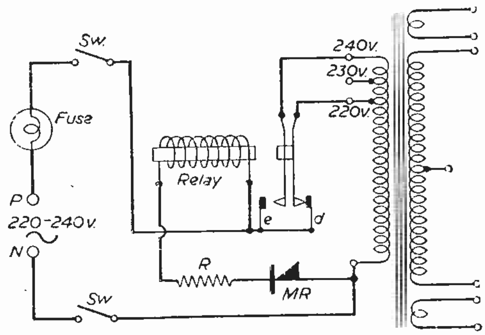


Fig. 6.—A relay-operated tap selector.

A.C. Type Power Supplies

Where supplies are obtained from a transformer the DLS1-DLS10 type delay tube is compact and useful. Fig. 5 depicts its use with a metal rectifier, as it is preferable to heat such a tube from a separate L.T. winding. By making use of two half-wave rectifiers, as shown, such a winding is made available, and an orthodox mains transformer can be used. It must be remembered that each metal rectifier must be rated at the full H.T. voltage and current output. A 5 Ω 20-watt variable potentiometer may be connected in series with DLS10 if control of its operating point is required.

In many 50 to 100 watt amplifiers and modulators, cathode biased valves are used with a directly heated output combination in push-pull or parallel push-pull. In a power pack for such equipment delayed H.T. switching is more or less essential.

Supply Regulation

When a domestic receiver is transferred from one place to another it is invariably connected to the supply without further adjustment to its transformer primary selector panel. Very often no adjustment is needed, but frequently such receivers are used in areas where the supply A.C. voltage is up or down by as much as 10 volts, due of course, to bad supply regulation.

In sets whose H.T. line voltages are comparable with that of the mains input voltage, this 4 per cent. variation is of little account. Users of really powerful equipment, such as large audio amplifiers and E.H.T. units, would, however, be forced to allow for this variation. On an E.H.T. secondary a 200-volt rise or fall could result from such a 10-volt variation, and a 20-volt change on a 500-volt secondary.

On a transformer tapped at 240-230-220 a change from 220 to 240 volts would result in something approaching 10 per cent., a phenomenon not as uncommon as one might suppose. The secondary variations discussed would thus be doubled.

Supply voltages change fairly quickly when regulation is poor, but tend to maintain their subsequent level for lengthy periods of time. The author has been at pains to observe this condition and has frequently measured 260 volts instead of the nominal 240 in his district.

An Automatic Tap Selector

The following device was designed to overcome this trouble:

A relay is wired in series with a resistance R and a metal rectifier across the mains input to a transformer, its contacts, one make-one break, being connected to the highest and lowest primary tappings, as in Fig. 6. R is of such a value that the relays minimum operating current is reached when the supply voltage falls midway between the nominal tap voltages 240-220, i.e., 230 volts. From a study of the circuit it will be seen that it will limit mis-volting of the primary to some 10-volts rise, or fall, about the 240-volt tap and a 10-volt rise above the 220-volt tap. Such a wide regulation is, of course, not ideal, but Fig. 6 does serve to illustrate the principle of such a device.

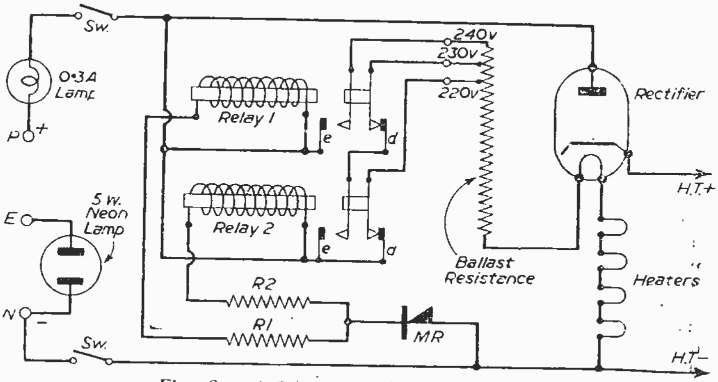


Fig. 9.—A.C./D.C. relay-operated feed.

Method of Determining R

When choosing a relay it must be remembered that with R it will form a current shunt across the mains input, and should thus be chosen for its small current drain. A relay of the 1,000 Ω type is indicated. Fig. 7 depicts a convenient method of finding a relay minimum operating current. The wire-wound variable resistance can be similar in value to the relay coil resistance and is placed in series with it, a milliammeter of about 0-10 mA f.s.d., and a grid bias battery of the −9 volt type. By gradually stepping the voltage up and at each setting varying VR from maximum to minimum, a point will be reached when the relay contacts suddenly open. At that point the milliammeter will read its minimum operating current.

This and the relay resistance will, by Ohms law, give the minimum voltage required to activate the relay. The voltage drop required across R will therefore be the difference of this and the intertap voltage, i.e. (230 volts). R now equals (230 volts).

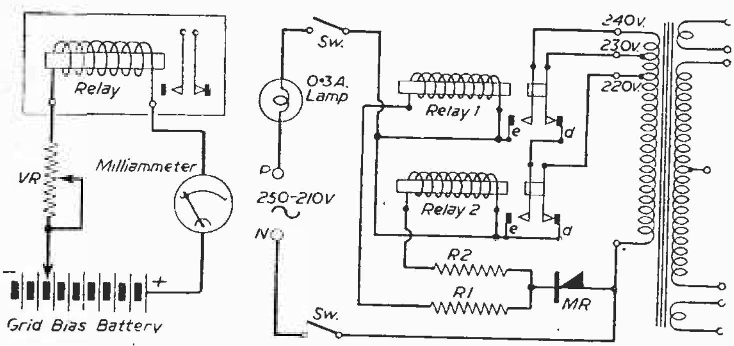
It is useful to place a fuse in series with the relay circuit, and a 0.3 amp. flashlamp bulb in a miniature M.E.S. batton type holder would be excellent. On small mains transformers this fuse could be made to fuse both the relay line and primary winding by positioning it, as shown in Fig. 6.

Multi-tapped Inputs

Most mains transformers are provided with three or more primary taps. Where it is desirable to regulate the input voltage closely over three or more of these extra relays must be incorporated, i.e., where N taps are to be used (N-1) relays are required. Such wide range regulation will not normally be required, and the use of three taps closely regulated should be sufficient for most purposes. Such a unit is outlined in Fig. 8.

The "critical" voltage for relay 1 plus R_1 will be 235 volts, and for relay 2 plus R_2 225 volts. R1 and R2 must, of course, be determined as for R in Fig. 6 after the relays are chosen. Should such a choice result in awkward values for R1 and R2, they should be made as near as possible to the correct values, and a small wire-wound variable resistance inserted in each relay line. In this manner exact values can be obtained and, if required, an adjustment of the operating relay voltage effected.

A metal rectifier (MR) is shown in Fig. 6, as it is improbable that A.C. type relays are available to a majority of constructors. It should be capable of carrying the combined relay currents, and be rated at the highest possible input voltage, i.e., 260> 250 volts. An A.C./D.C. circuit is shown in Fig. 9.



Figs. 7 and 8.—Finding relay current and circuit where several taps are used.

An Intermittent-fault Finder

A VALUABLE ACCESSORY FOR THE SERVICEMAN

By E. A. Cosham

THE instrument to be described was primarily designed for locating those difficult faults, the intermittent.

Most amateurs, experimenters and servicemen alike, have, on different occasions, met with receivers having the following fault.

A set will function normally for a time and then suddenly go dead. On touching the set with a meter, signal tracer or other instrument, the set immediately behaves normally and the process has again to be gone into of waiting for the set to go dead ; touching it again starts it working as before.

This fault can be caused by a number of things, almost all mechanical—a dirty valve pin, dry joint, faulty component or faulty dirty switch contact. Sometimes a valve electrode can be the culprit. No component can be above suspicion.

The writer has, on occasions, had sets to service that have acted as described and, in exasperation after wasting considerable time, found the only way of locating the fault was to prod and poke gently every lead and component until there was some indication—loud crackles or rapid "on/off" of the signal—that the fault was found.

Description of Unit

In Fig. 1 it will be seen that the instrument is composed of four separate circuits, each a simple detector, with its own current indicator ; also each circuit has its own input lead. For stability sake each stage is screened from the other, above and below the chassis.

When the instrument is in use the four input leads can be, if necessary, connected to different parts of the set undergoing test, thus giving four simultaneous indications. Assuming the instrument is connected to a set, say, at the points shown in Fig. 2, it will be seen that immediately a fault occurs it will be indicated by meter(s). Although this does not inform us as to the exact position of the fault, at least it does narrow it down to two or three components which it should not be difficult to locate.

Stages two and three are shown with controlled inputs. When in use these two are actually used at the last two points being tested in a set, the reason they are not shown as stages three and four is to allow the front of the instrument to be uniform. When in use, therefore, stage one will be used as such, at the first test point, and stage four will be the second. Two controlled inputs are used because the last indicator, number three in the instrument, will almost always be used in the output of a set, and will receive so heavy an input that the flag will go beyond the zero point, and often to the stop. In many powerful sets stage two will act likewise, as in most cases it will be used at the input of the output valve.

The Indicators

These are two of the ex-R.A.F. twin-meter cross-over units. When purchased they have only three indications marked on the dial, so a new scaled dial has to be drawn and glued on. Calibration is not necessary, but a dial set out with two sets of divisions is needed for taking readings. Fig. 3 shows one way of doing this. It will be seen that the meters are used in reverse to the general rule ; there should, however, be no confusion if this method is employed, when one remembers the principle on which the indicators are working, and this is borne in mind during tests.

It will probably be found that the meter cans are difficult to remove. The author found the best method short of cutting them, was to insert one end of an open pair of blunt-nosed pliers under the edge of the can and use the meter flange for levering on. This may be risky, however, if the can fits very tightly ; the only other way is to cut, with a fine hacksaw,

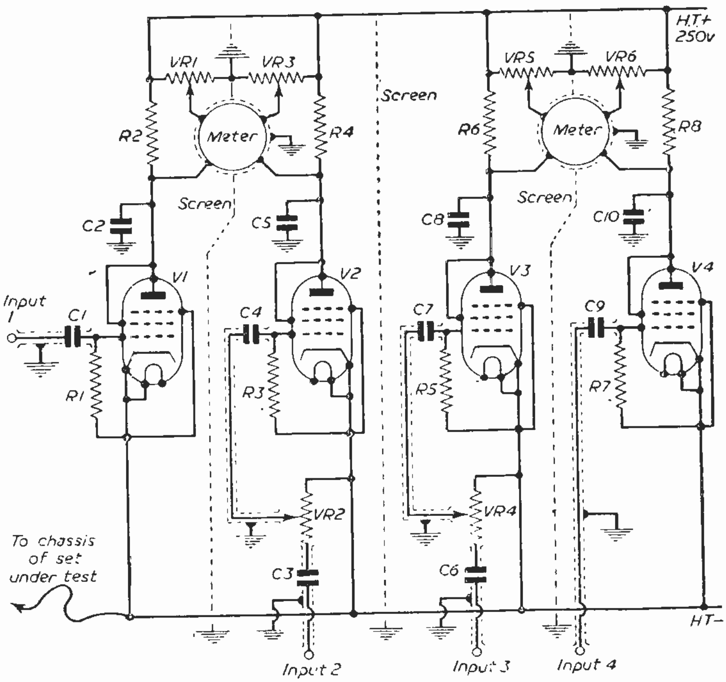


Fig. 1.—Theoretical circuit of the Tester.

through the can, from top to bottom. This necessitates cutting into the flange, but if a very fine saw is used and one does not cut deeper than just through the can, little damage is done. The cans are saved and replaced, after the new dials are fitted, to act as screens.

Fig. 4 shows connections of leads to the meter terminals. If the meters are required to read conventionally one need only reverse the leads.

The original of the testing instrument had the input leads going straight into the set; the author preferred this method as there is less possibility of faulty readings, than if plugs and sockets are used and these are not absolutely secure and always clean.

A mechanical safety device is fitted to each meter

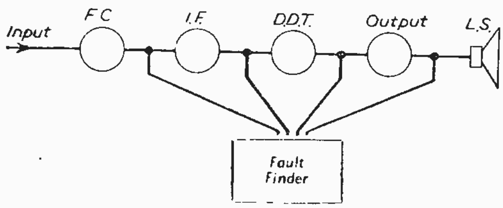


Fig. 2.—Indication of testing method.

potentiometer to prevent overloading, for, as will be seen from the main circuit, if the moving arms of the potentiometers are moved completely to H.T.+, the meters can be ruined. When in use the arms come into contact with stops after sufficient voltage is developed across the meter to drive it to a little beyond full scale. The safety device is fitted as follows. If the potentiometers have round spindles, and they usually have, after the surplus is cut away, a flat portion must be filed. This should be from ½in. to 1in. long. Make it in the same position on all four spindles, relative to the direction in which the arms are pointing. Fit each potentiometer with a pointer knob. To complete the device the instrument must be in working condition. Before switching on turn each meter potentiometer until it is about three-quarters advanced, i.e., clockwise, and on no account advance them further than this amount. Now switch on and, after the valves have warmed-up, it will be noticed that the meter flags have all settled at different positions on the dials. To adjust, taking stage one first, if the flag has gone beyond F.S.D. to the stop, turn the relevant control knob very slowly in an anti-clockwise direction; the flag should begin to move back, and if the knob is not turned with care the flag will fly quickly to the other stop. When the flag has barely left the stop make an indentation on the chassis on the opposite side to the pointer on the knob to the direction the knob is taking. After this carry on turning the knob anti-clockwise until the flag barely reaches the other stop, now repeat the former process of making an indentation, but on the opposite side of the pointer. This done drill two holes, one at each mark, so that two stops may be fitted. These can be engineered to suit the constructor.

It is best, in the author's opinion, to put identifying marks, or numbers, on each meter and its respective input lead. This could be done by painting coloured spots on the meter fronts, and corresponding bands of colour around the ends of the leads, there can then be no confusion when the set under test fails and the indicators are being studied.

COMPONENT VALUES (FIG. 1)

Condensers:
- C1, 4, 7, 9 = .0001 µF (mica).
- C2, 3, 5, 6, 8, 10 = .01 µF (mica).

Resistances:
- VR1, 3, 5, 6 = .25MΩ.
- VR2, 4 = 5MΩ.
- R1, 3, 5, 7 = 4MΩ.
- R2, 4, 6, 8 = 1MΩ.

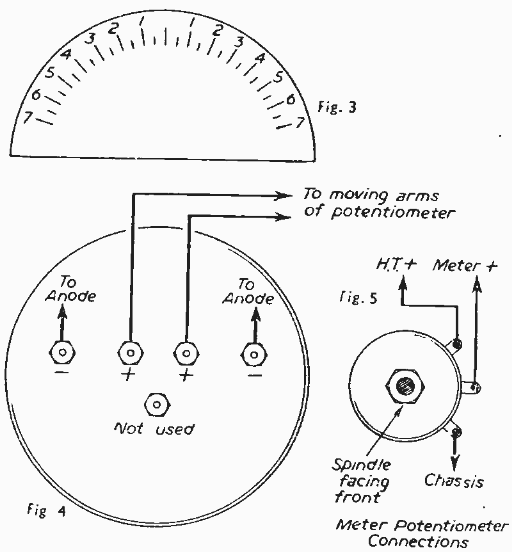
Valves:
- 1, 2, 3, 4. VR65 (SP61) or VR65A (SP41).

Application

The instrument is best used in conjunction with a modulated test oscillator. If this, or some form of modulated oscillator is not handy, a broadcast signal, picked up by the set under test will have to be used. The disadvantage with the latter, however, is that the indicators testing the L.F. side of the set rise and fall with the signal and with another type of intermittent fault, mentioned later, this can be irksome.

When everything is ready to carry out a test connect the four input leads in, as shown in Fig. 2. Avoid direct anode connections except in the L.F. stages; with the H.F. stages use grid circuits, or any convenient point between the valves where the signal can be used. When this is done, and the oscillator, or aerial is connected to the input of the set, switch on the instrument and allow to warm-up. Adjust the indicators so that they are set to read number one on the dials. Switch on receiver and test oscillator. Increase the output of the latter until the indicator(s) on the H.F. side of the instrument give a good reading. It will be noticed that a much larger reading is probably being registered on the first L.F. indicator, while the last indicator, which in most cases will be connected to the anode of the output valve will more

(*Continued on page 50.*)



Figs. 3, 4 and 5.—Wiring to the meters and potentiometer, and dial details.

On your Wavelength

by THERMION

The Radio Service Engineer

MR. A. HARRISON, hailing from the salubrious district of West Hartlepool, crosses swords with me in a didactic and would-be humourous letter on the subject of radio service engineers. He says that it was representatives of the Guild of Radio Service Engineers and the Radio and Television Retailers' Association who formed a committee which was finally responsible for the current wages agreement. He does not agree that the average wage is between £8 and £9 weekly, and informs me that the secretary of the R.T.R.A. recently sent a circular to all members asking them how many engineers they employed and was the dealer paying the minimum, or less, or more. The replies could be made under the seal of anonymity, and he thinks the implication of this obvious. I agree that high prices for service do not necessarily mean that the engineer is getting a high wage, and that free service is at the expense of the engineer's wage. My correspondent also tells me that five of his friends, who were first-class men, have left the trade because wages are poor and they could earn more in other industries with less knowledge and responsibility.

Ebor on Sponsored Programmes

DR. GARBETT, Archbishop of York, recently expressed his views on the subject of sponsored television programmes, and as many of his strictures apply equally to sponsored radio programmes, they are worthy of comment. He says that television viewing may occupy far too much time because seeing requires more concentration than hearing. This is inverted logic. With listening, the brain is compelled to build up a mental picture of what is happening in the studio and one cannot rely upon listening alone to complete the picture. There is thus more concentration required than with television where the vision and the sound are synchronised, and the mind is relieved of the task of supplying the missing link.

His second objection was that there is a danger that television may become a substitute for intelligent thought and reading. He said that inquiries show that 42 per cent. of those interviewed stated that since they had a television set their reading had diminished. Yet the sales of newspapers and all types of books have increased enormously.

His third objection was that television may bring into the home sensational and horrific pictures of crimes of violence, murder and suicide, and may cater for popularity by the presentation of short sensational stories which are either immoral or brutal. Would Dr. Garbett, therefore, expunge from the Bible those passages to which these strictures also apply?

Another of his objections is that television may become the means of subversive and political propaganda which would poison the mind and destroy independent judgment. "Few of those who have experienced in America commercialised television programmes would wish to see this system reproduced in England." That may well be, but I think it right that both radio and television should fairly represent all shades of political opinion, just as all shades of religious beliefs have been presented by radio and by television. Dr. Garbett should remember that we do not listen-in or look-in necessarily for enlightenment, but for entertainment. Both of these new media of entertainment are only intended to a small extent to be educational. We do not want to go back to school when we are looking-in or listening-in, and really the subject is not within the province of the Church to discuss.

Our 21st Birthday

THIS journal will celebrate its coming of age on September 24th next year. It hardly seems 21 years ago since we launched this journal including with every issue of No. 1 a free blueprint for a Long Range Express Three. This was followed by the Fury Four, the £5 Super Het, the Qualitone and many other receivers which are still being operated in various parts of the country, having given continuously satisfactory service. We shall celebrate our 21st birthday in a manner later to be disclosed.

Your present scribe has been connected with this journal right from the start and well remembers the enthusiasm with which the first issue was received by the public. It rapidly sailed into the leading place and also saw the early demise of its 11 competitors. Verily, it is said, that to have been first merely proves antiquity.

Naturally, there was resentment at what was considered an intrusion by a newcomer into a domain which had been ruled over by others for so long: but it was felt by the founder and the proprietors that the journal had a mission to perform: indeed, a crusade to conduct to safeguard the interests of constructors. In the first place the solus specification was adopted as part of the editorial policy, and this was backed up by the issue of our guaranteed circuits and free service guarantee. The second oldest journal was "Amateur Wireless," upon which I also served in its early days. It did not withstand our competition and it came home to roost. The merger was announced without any loss of dignity to it. Our press announcement to readers of the dying journal was: "Two famous journals combine," and our title was changed to "Practical & Amateur Wireless." We have long since reverted to our original title. Not so long after the death of "Amateur Wireless" its chief competitor, "Popular Wireless," publication No. 1 of which preceded "Amateur Wireless" by one week, also died. "Modern Wireless," "The Wireless Constructor," "Radio Trade Review" and many others followed suit.

Predicting Amplifier Response

FACTORS USED IN WORKING OUT FREQUENCY AND GAIN VALUES

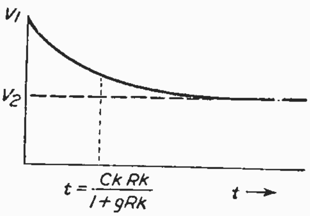
By N. J. Wadsworth, B.Sc.

(*Continued from page 574, December, 1952, issue*)

THE screen grid impedance may be calculated from the characteristics of the valve, when triode connected, by the formula

$$rsg = ra(t)\ \frac{Isg + Ia}{Isg}$$

where ra(t) is the anode impedance, when triode connected, and Ia and Isg are the anode and screen grid currents. If the valve is run with low electrode voltages, the effective rsg may be higher than that calculated above. If this is so and is neglected, the performance will be slightly better than that calculated. If the calculated capacity is too big for convenience, the solution is to use either a lower-resistance potential divider with correspondingly large waste of current, or valves whose screen grids may be run direct from the H.T. line, or to dispense with



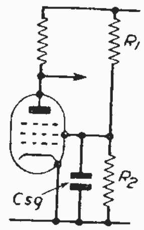


Fig. 6 (left).—Square Wave response of the circuit shown in Fig. 4. Fig. 7 (right).—A screen-grid stage.

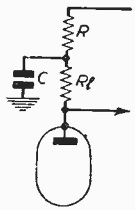
Csg and incidentally reduce the gain. This cause of drop in response at low frequency needs watching, but is seldom as serious as the two previous causes.

Another cause of phase shift, and in this case of rise in response at low frequencies, is anode decoupling as in Fig. 8. Considering pentodes first, the gain and phase-frequency characteristics are shown in Fig. 9. $G1 = g\ (R + R_l)$ and $G2 = gR_l$, $f_o = \frac{R + R_l}{2\pi CR\ R_l}$. The graphs of Fig. 2 or Table I may be used for this, interpreting the phase shifts as a lag and taking the reciprocal of the voltage output given and reading the db drop as a raise. This will hold down to the point where the gain is about half way between G1 and G2. For frequencies below this, the response must be worked out for each ratio of G1 to G2. The response of Fig. 8 to a square wave is shown in Fig. 10 where $V1/V2 = G1/G2$. It will be noted that the curves are the inverse of those showing the effect of finite size of cathode capacitor. If the circuit of Fig. 11 is used, the results will cancel out exactly if $R/R_l = gRk$ and $RC = RkCk$, and the response curve will be flat at all low frequencies and the phase shift zero. However, C and R no longer act to decouple the valve from the H.T. supply. Any drop in response and phase shift, due to inadequate screen decoupling and to small coupling capacitors, will still persist of course.

In the case of a triode, the effect of the decoupling capacitor is smaller and when R_l is much greater than ra, the anode impedance, the effect may be ignored.

High Frequency Response

At high frequencies the performance is limited by the shunt effect on the anode load of the capacity to earth of the anode of the valve, Cout, the wiring, Cw, and the grid capacity of the next valve or the plate capacity of the C.R.T. it feeds, Cin. The effect



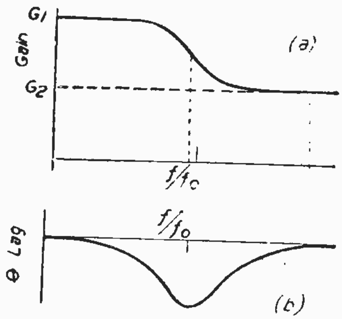
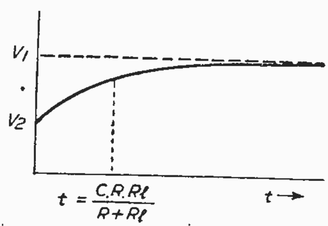


Fig. 8 (left).—Anode loads and decoupling. Fig. 9 (right).—Gain and lag curves.

of these is to cause a drop in response and a phase shift as the frequency is raised. This is shown by Fig. 12 where f1, the new reference frequency, is given by $f1 = 1/2\pi R_l Ct$, where R_l is the load of the valve and Ct is the total capacity $Cout + Cw + Cin$ as in Fig. 13. Table II gives values of the relative output and db loss together with phase shift, ϕ, for various values of f/f1. It will be seen that it is desirable to keep Cw as small as possible. This means that wire must be kept as short as possible and the capacity to earth of the coupling capacitor Cc kept low. This opposes the criterion for good low-frequency response that Cc must be as large as possible, and a compromise must be reached. Cout is fixed by the valve used as is Cin, but in the latter case care must be taken when using triodes as, owing to the Miller



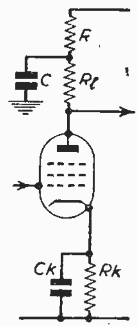


Fig. 10 (left).—Response of Fig. 8 circuit to a square wave. Fig. 11 (right).—Alternative L.F. circuit.

effect, their input capacity $C_{in}=C(g-c)+AC(g-a)$ where A is the amplification of the valve. Thus, for example, a 6J5 has a grid to cathode capacity $C(a-c)$ of 3.4 pF and a grid to anode capacity, $Cg-a$ of 3.4 pF also. If it is working with a gain of 15, the input capacity is $3.4+15\times3.4=54$ pF which will reduce the high-frequency response of the preceding valve considerably. For this reason, triodes are rarely used in oscilloscope amplifiers. $Cg-a$ for pentodes is commonly below 0.008 pF and so the Miller effect is unimportant. It is also advantageous to keep R_l as small as possible, but reducing this also reduces the gain (gR_l). A very useful criterion for choosing valves for oscilloscope amplifiers is the ratio $g/(C_{in}+C_{out})$. The larger this is the more gain may be obtained for a given H.F. response or, conversely, a better response may be obtained for the same gain. Table III gives g and ($C_{in}+C_{out}$) for a number of valves, together with their ratio. The output stage of an oscilloscope is the most difficult to design as the input capacity of the deflection plates is often about 25 pF, making a total capacitance of at least 30 pF, and the valve must provide sufficient output to deflect the spot right across the tube. If push-pull deflection is used, the output from each valve may be halved so R_l may be halved, thus doubling the upper frequency limit. Having decided the required peak-to-peak output voltage, R_l is chosen to give this with the anode current swing available from the valve chosen. From this and an estimate of Ct, the H.F. response may be predicted. If a valve with a larger anode current is used, R_l may be reduced and in this position it is possible to obtain an increased H.F. response by using a valve with a lower $g/(C_{in}+C_{out})$, but a larger anode current. If the response as determined above is not good enough, it may be improved in a number of ways. The first is by using a small cathode by-pass capacitor so that the increase in gain, shown in Fig. 5, occurs at the same point as the drop in Fig. 12. This occurs approximately when $C_tR_l=\frac{gRk^2\ Ck}{1+gRk}$. In this case the gain is reduced to G2 in Fig. 5. Another method

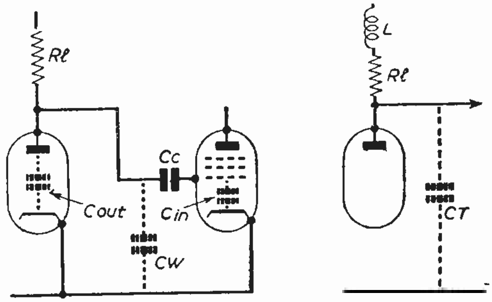


Fig. 13 (left) and Fig. 14 (right).—Stray capacities, to be studied in conjunction with Tables II and III.

is to put a coil in series with the anode load as in Fig. 14. L should be about $400,000\ C_tR_l^2$ henrys.

In Figs. 15 and 16, the effect of increasing L is shown. The introduction of L does not completely remove the phase shift but does reduce it considerably. By these means, the output may be maintained reasonably constant almost up to f1. For a fuller account of corrector circuits of various sorts, the reader is referred to the text books.

If several valves are used in succession to amplify the signal, the total response curve may be calculated by considering the response of each valve and coupling in turn and then adding the phase shifts produced at any frequency to get the total phase shift at that frequency, and similarly adding the db drops and gains. If the gains are expressed as voltage ratios, these must be multiplied together. Thus, if one valve gives a 45 deg. phase lag and is 3db down at 20 kc/s and the next gives a 1db drop and a 30 deg. phase lag, the two together will be 4db down and lag 75 deg. at 20 kc/s.

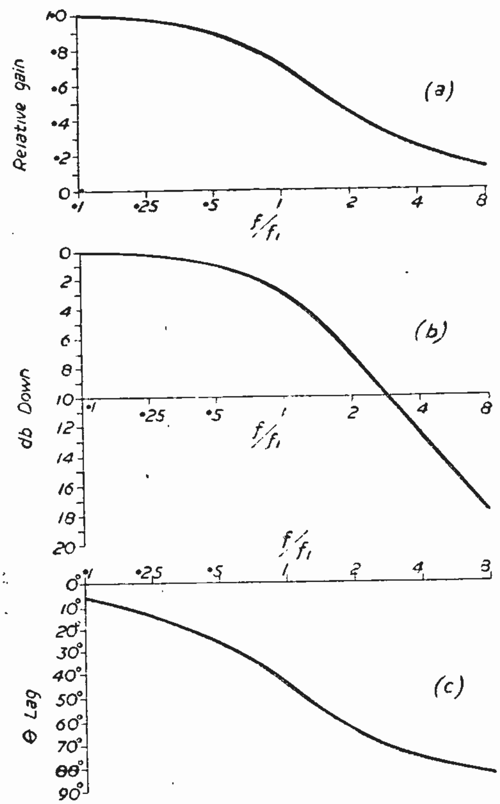


Fig. 12.—Curves showing response curves and phase shift.

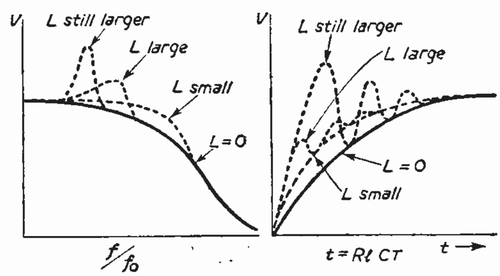
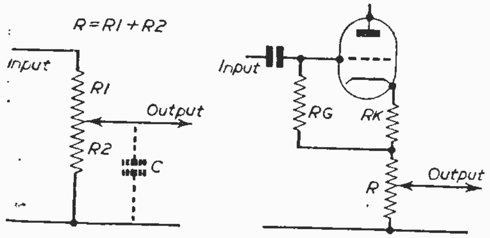


Fig. 15 (left).—Frequency response of Fig. 14, and Fig. 16 (right) transient response of Fig. 14.

Gain Control Circuits

Almost every amplifier has some means of varying the gain and often very little thought is given to it. As an example of a type in common use, which is no good at all for oscilloscopes, consider the 1 MΩ potentiometer. This may be represented as in Fig. 17. When the slider is at the top of the potentiometer, the capacity across the output C, which represents the input capacity of the next valve, plus wiring capacities, and may be large if screened wire is used, is across the input. If there were no potentiometer there, this would be the same, and its effect could be calculated as above. When, however, the slider is near the middle of the track, C comes across the lower half only and the response due to this is that shown in Fig. 12 with $f1 = \frac{R_1+R_2}{2\pi CR_1R_2}$. If R1=R2=0.5 M$\Omega$ and C=20 pF, a likely value, f1=16 kc/s, and from Fig. 12 or Table II we see that there is a phase shift of 10 deg. at 2.8 kc/s and of 30 deg. at 9 kc/s which, while it may not matter much for audio work, is useless for an oscilloscope. To improve this, f1 must be increased a lot, and as C cannot be reduced much, R must be reduced. If this is done, however, the loading on the input is increased, and as it is essential that oscilloscopes have as high an input impedance as possible, this is ruled out. There are two common solutions to the problem. One is to use a cathode follower valve in the circuit shown in Fig. 18 with the potentiometer R as the cathode load; Rk provides the grid-bias. In this way the input impedance of the valve is made many times Rg, owing to the negative feedback, and R may be made 5 KΩ or 10 KΩ quite easily. It is essential that the maximum peak-to-peak input voltage shall not be larger than about 1.5R times the mean anode current to prevent overloading, but an SP61 or an EF50 passing 10 mA and a 5 KΩ potentiometer will handle up to 60 volts or so p-p, and anything larger than this may be fed straight to the C.R.T. The maximum gain of this stage is about 0.95.



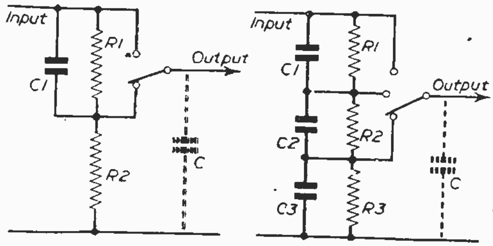
Figs. 17 and 18.—Gain Control in its common form, and a cathode-follower circuit.

The other solution is to use a stepped, compensated attenuator. An example is shown in Fig. 19, where if C1 R1=CR2, the division ratio is R2/(R1+R2) independent of frequency. A three-step attenuator as in Fig. 20 may be used. If C1R1=C2R2=C3R3 and C1 $\gg$ C, the output will be independent of frequency, but the input capacity is high.

Generally, the first method is the most suitable and gives the best results. If the second method is used the capacitors will have to be adjusted for best response and this needs a good test oscillator.

A variable-mu valve must not be used as a gain control owing to its inherent non-linearity.

It is hoped that the above account will encourage more people to design their own oscilloscope and other amplifiers, to give wanted response curves, and to spot the causes of bad response in existing amplifiers.



Figs. 19 and 20.—Stepped, compensated volume control.

TABLE III

Valve	g ma/V	Cin+Cout pF.	g/(Cin+Cout)
6J7	1.2	16	.075
SP61	8.5	20	.425
EF50	7	15	.47
6AH6	9	13.6	.66
CV138	7.5	11	.68
6AK5	5	6.8	.73

Two New Books

TWO new books have been published by Cleaver-Hume Press, Ltd., for Philips Technical Library, as follows :—

"TELEVISION" by F. Kerkhof and W. Werner of the Philips Laboratories at Eindhoven, Holland. Price 50s. from Cleaver-Hume Press, Ltd., 42a, South Audley Street, London, W.1.

This book has been written for technicians and engineers who have a good basic knowledge of radio theory. It makes clear the essential physical principles on which current practice and future advance must be based.

"ARTIFICIAL LIGHT AND PHOTOGRAPHY," by G. D. Rieck and Ir. Verbeek of the Philips Lighting Laboratories at Eindhoven, Holland. Price 57s. 6d. from Cleaver-Hume Press, Ltd., 42a, South Audley Street, London, W.1.

This must be the most comprehensive treatise of the kind extant. Professional and technical photographers will find it invaluable for study and reference; many amateurs will be intrigued by the dozens of examples (some coloured) of work by leading artists, with full data on posing, exposure and processing.

A Quick Capacitor Tester

ANOTHER AID FOR THE EXPERIMENTER OR SERVICEMAN

By J. C. Flind

DEFECTIVE capacitors have probably been responsible for more gnashing of teeth in the amateur construction world than any other class of component, especially as in recent years there has been a strong temptation to acquire them cheaply by stripping down ex-Service equipment, sometimes of doubtful vintage. Only too often a piece of apparatus, laboriously built up, fails to function satisfactorily, and the cause is traced by a long process of trial and error to a capacitor which is leaky, or to one incorrectly chosen owing to its being marked only with a Service code number, easily mistaken by the uninitiated.

Of course, a rough test for D.C. leakage can be made with a high-tension battery and a milliammeter, but a slight error easily leads to irreparable damage to any expensive instrument, so that many experimenters prefer to take a chance or perhaps buy new components for all their undertakings.

The small instrument to be described will work on all usual A.C. mains voltages, and is easy and quick to use. The two test leads terminating in bulldog clips have only to be affixed to the " suspect " whereupon a turn of the switch immediately indicates whether leakage is present or not. By a second movement of the switch, without touching the component under test, A.C. is applied, and the other possible breakdown, an internal open circuit, is disposed of. Finally, still without touching the capacitor, the control knob and scale fitted will give a pretty good idea of the actual capacity between the limits of .1 μF. and .0005 μF. (the leakage and continuity tests, of course, apply to all capacitors down to 100 pF. or less, but readings become rather crowded at the lower end of the scale).

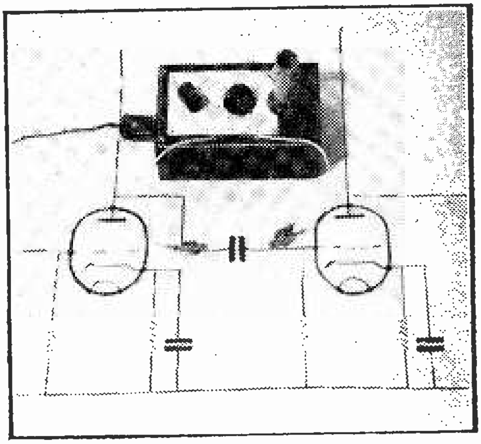
Higher capacities than .1 cannot conveniently be directly measured, though the insulation test still applies. Resistors having ohmic values between about 20,000 ohms and 10 megohms, beyond the range of the usual multi-meter, can also be tested for continuity and their values, up to two or three megohms, estimated with a fair degree of accuracy.

A leakage or insulation breakdown up to at least 20 megohms is clearly indicated.

The Circuit

Although the instrument is mains driven it can be left connected up when not in use, as in the neutral position of the switch it consumes no current and the test leads are out of circuit, so that they can be handled without risk of accidental shock.

The circuit is simple and calls for few components, most of which will already be at hand; it will be seen that for both D.C. and A.C. tests, the capacitor under test is connected in series with a neon lamp, and that in the A.C. position a variable resistor is



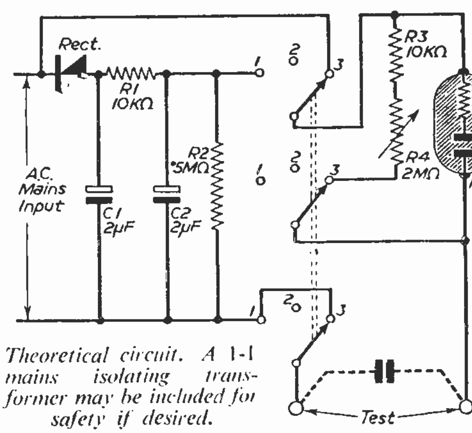
shunted across the lamp; the purpose of this will be explained later.

The neon indicator is in no way a special job; it is the well-known " pigmy " 0.5 watt, used as a telltale on electric cookers, etc., and freely and cheaply available from dealers everywhere. The circuit has been expressly designed to employ the usual commercial pattern, with the limiter resistor inside the cap, so that the lamp cannot be overloaded and damaged, even if the component breaks down under test or shows an unexpected dead short-circuit.

The Layout

Layout is by no means critical: the original instrument was made up in a box some 6½in. × 4in. × 2½in. deep, and it is suggested that the " working parts," consisting of switch, variable resistor, and a bayonet type lampholder, should be mounted on the panel forming the lid, leaving the box for the power pack. The mains supply is led in at " ground level " by a two-pin plug screwed to the side of the box, and only three leads are needed to connect the power pack to the 3-pole 3-way switch which acts as a distributor.

This switch in position 1 connects one test lead to earth and the lamp, attached to the other test lead, to D.C. positive, leaving the variable resistor R4 out of circuit altogether. In position 2 the



Theoretical circuit. A 1-1 mains isolating transformer may be included for safety if desired.

circuit is broken in both live and dead poles, while in position 3 the D.C. supply is disconnected, and full A.C. mains voltage applied, through the test leads, to the lamp. In this position, too, the third pole of the switch connects R4 in parallel with the lamp.

Operation

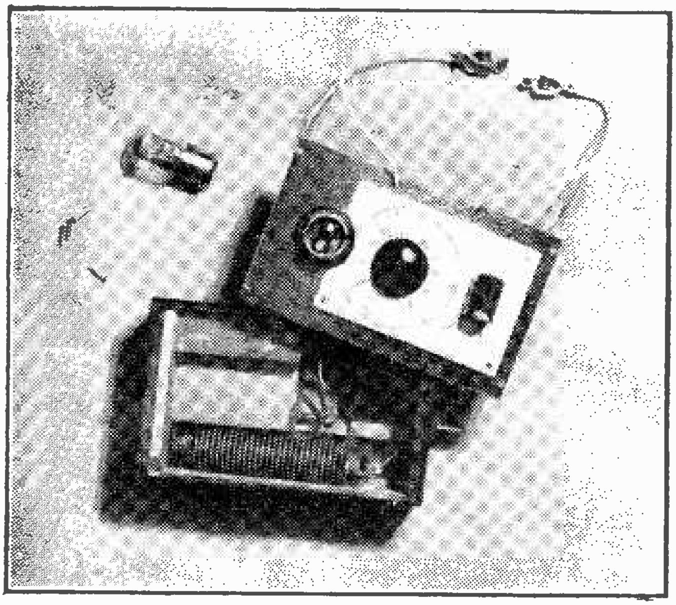
When the unit is connected up, with the switch in neutral, a capacitor is clipped between the leads and the switch turned to position 1 for leakage test. Given a good component, there will be a single flash, of greater or less intensity according to the capacity in circuit, after which the neon will remain dark. A fairly good capacitor will allow the neon to flash again at intervals ranging from a few seconds up to a minute or more, while a really bad one will permit a continuous glow to be seen.

Assuming the component passes this test it is left attached to the leads, and the switch is moved to position 3, allowing A.C. to flow continuously through both capacitor and neon. There will be a voltage drop, divided between the capacitor and the lamp in the proportion of the opposition which each opposes to the flow of current: in the case of the lamp this is practically a pure resistance, while the capacitor offers a reactance. (While it makes no difference to the practical working of the instrument, it is worthy of note that the two "oppositions," although both expressed in ohms cannot be compared directly—owing to the phase differences introduced they are in quadrature which means that their algebraic sum is equivalent to the square root of the sum of the squares of the two elements.)

If the capacitor is large enough, and the full value of the variable resistor R4 in circuit, the neon will strike and will remain alight; then by slowly reducing the resistance in parallel with the lamp the voltage across it will be made to fall to a point at which the glow is extinguished. It will be found that the setting of R4 offers a measure of the capacity of the component under test, and a scale, reading directly in microfarads, can be calibrated. A supplementary scale for checking resistors, and reading directly in ohms, can be added if desired, but the constructor should be warned for the reasons given above against calculating its readings from the capacitor reactances; it is preferable to calibrate each scale separately.

With a .1 μF capacitor under test the current, at the moment of extinction of the neon glow, will be about 6 mA., more or less, according to the characteristics of the lamp and the mains supply voltage. Most of this current is carried by R4 so it is inadvisable to prolong this part of the test longer than necessary. Fortunately, it is not important that R4 should be in first-class condition, and in the prototype a discarded 2-megohm volume control was employed. A small section of the carbon track was carefully scraped away, so that in the maximum-resistance position it actually open-circuited, so leaving the neon without any shunt at all. In this way, under favourable conditions, capacitors as low as 50 pF. can be tested for continuity as well as for D.C. leakage.

The fixed resistor of 10,000 ohms R3 is intended to limit the current which can flow through R4 towards the end of its travel—this value was chosen to permit the instrument to read up to .1 μF. A lower value of R3 would extend the range to include higher values of capacity but would increase the risk of burning out R4, while a higher value, though it reduces the strain on R4, would limit the range of the instrument. A possible refinement, which has not yet been tried out, would be to replace R3 with a variable resistor, capable of carrying, say, 50/100 mA., and so extend the instrument range up to 1 μF. or beyond.



The unit opened to show interior.

Power Supply

Turning now to the power pack it will be seen that this is reduced to the simplest possible proportions. All that is needed is a surplus metal rectifier plus a couple of capacitors to provide the smoothing. The power demand is so small that 2 μF. in conjunction with a 10,000 ohms resistor will do all that is needed. A .5 megohms bleeder resistor is included to avoid leaving the D.C. live end "in the air." The lay-out of these components can be clearly seen in the photograph.

The larger capacitors, both on A.C. and D.C., will give a brilliant illumination on the neon quite unmistakable under ordinary room lighting, but in order to deal with the smaller sizes some form of light shield is advisable. In the prototype, this was provided very simply by a short rubber sleeve originally intended as a handle grip for a table tennis bat. This has merely to be drawn over the neon bulb (a little French chalk or talcum helps) and cut to a suitable length.

Printed Metallic Circuits

DETAILS OF AN IMPORTANT DEVELOPMENT IN THE ELECTRICAL AND ELECTRONIC INDUSTRIES

By F. J. Camm

THE wiring of electrical circuits by the usual methods leaves a great deal to be desired. Usually this is performed by unskilled labour, and the risk of wrong connections, badly made and high-resistance joints is ever present. The checking after assembly of complicated circuits and subsequent rectification is costly. In recent years developments have taken place in what are known as printed circuits, which are really the complete wiring layout of an electrical circuit printed on metal attached to an insulating base: this is subjected to acid treatment as in ordinary block-making, which eats away *the unwanted portions* of the metal, leaving behind the metallic point-to-point connections. The connecting terminals can be formed on the ends ready for connection to the components. In cases where wires have to cross and be insulated from one another, the foldable metallic circuit has been developed and, in this case, the insulated base is metal-coated on both sides.

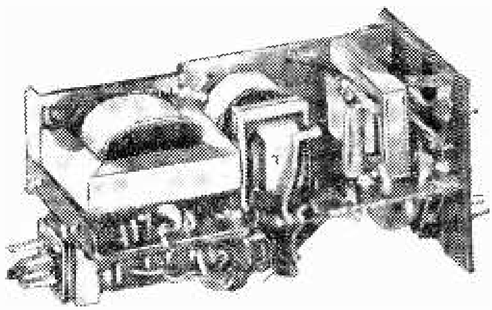


Fig. 1.—A five-valve receiver made from the printed circuit shown below.

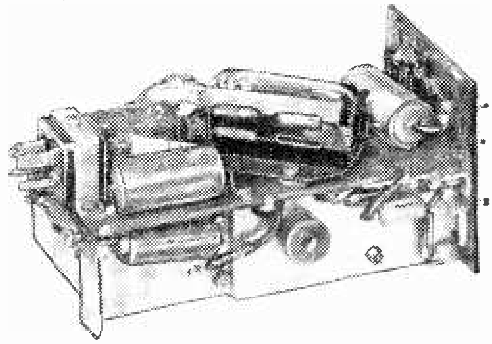


Fig. 2.—Another view of the five-valve receiver.

The process has many other applications. It can be used for printing transformer windings, wireless coils and, in fact, for most other purposes where wire is normally used. There is thus no possibility of error, the process of connecting up the components is greatly accelerated, inspection costs are greatly reduced, and there is great economy of material. It is also possible to create a tidier-looking wiring system. Any small lugs or terminals can be formed in the one operation.

Stencilling Process

This form of printed metallic circuit originated in America during the recent war. It arose by the development in the U.S.A. of the VT fuse, which made use of a form of prefabricated circuit produced by stencilling patterns composed of powdered silver on to thin wafers of a ceramic material, and then fusing the wafers at high temperature to secure adhesion of the metal to the base and also to fuse the powder into an electrically conductive pattern. It was the use of the stencilling process which gave rise to the term "printed circuit," which is really a misnomer and has given rise to some misunderstanding, since it could be confused with an electrical circuit as printed in a book. I prefer the term "printed metallic circuit." This stencilling process is still employed, but it is rapidly being superseded by the new system. The stencilling process suffers from the limitation that a ceramic base must be used.

While this stencilling process was being developed in America, an English firm, without knowledge of it, was proceeding independently with the system already

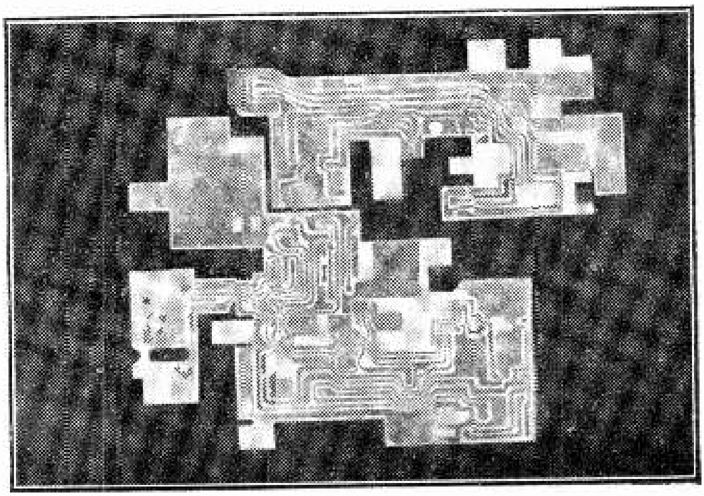


Fig. 3.—The foldable circuit for a five-valve vest-pocket receiver shown in Figs. 1 and 2.

outlined, and it has developed the process to the point where it has been taken up by important electrical manufacturers. It was realised that if wide commercial use was to be made of the new process, it would need to be adaptable to cope with the increasing development in the field of electronics.

Technograph Printed Circuits

It was later found that the Germans, too, had been making use of prefabricated circuits in certain of their electronic instruments, but nothing has been heard

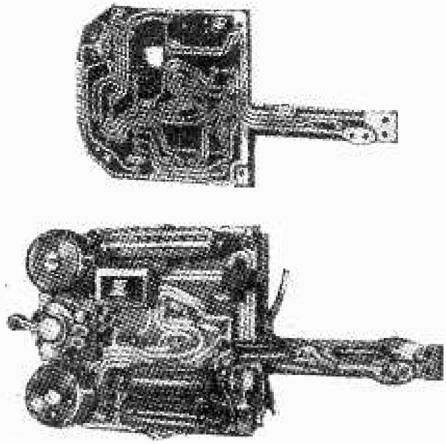


Fig. 4.—Top, the printed circuit and, below, the same circuit with the components attached.

since the war about any later developments. During the last four years, however, various processes for the production of printed metallic circuits have been announced by British and American firms, and although some of them do not use any printing process, the term has now become accepted as descriptive of all of them. Undoubtedly, the British system is the best and it is based on a patent granted in 1943 which is becoming known as the etched foil process, produced under the name Technograph Printed Circuits. This process does depend upon a printing stage in its production, but it is employed as a means of converting rolled metal foil sheets into a pattern of conductors which take the place of wires used in normal assembly systems and also as screening and earthing. The British process has, in fact, been adopted on a very considerable scale by American firms, and at the present time it is used far more extensively in the U.S.A. than in this country. The largest manufacturer of television sets in America is now changing over to etched foil circuits, employing automatic assembly methods by means of which he hopes to produce a television receiver every 23 seconds.

Printed circuits of this nature are produced in three main stages. The first is the making of a laminate comprising the particular metal foil to be used and the selected insulating base material; the second, the printing stage; and finally the etching process.

The Preparation of the Laminate

The kind of metal to be used and the nature of the insulator will be determined by the function of the circuit and the thermal conditions of operation. The foil is bonded to the base by means of a cement, this being chosen with reference to temperature requirements. In some cases a thermo-setting cement is used and in other instances a thermo-plastic type is adopted. If the circuit is a simple pattern it is usually possible to so contrive the wiring pattern that all the wiring connections can be formed on one surface only, and in such cases the laminate has metal foil bonded to one side only of the base; but where complex wiring is required, in which cross-overs cannot be avoided, then it becomes necessary to bond foil to each surface of the base and so arrange the wiring scheme that part of the circuit will be produced on one side of the laminate and part on the other, and thus at any cross-over point the pattern is terminated on one face and picked up again on the other side, by inserting a rivet or tag through the base and thus joining up the respective conductors.

It will, therefore, be seen that the conductors are formed, as described in the next stage, from rolled metal foil and not, as in some systems that have been advocated, from metal powder or colloidal inks. The use of rolled foil provides the best possible electrical and mechanical characteristics, and it was these considerations more than any others that influenced the development of the Technograph technique in favour of the etched foil process.

The Printing Stage

The printing stage depends first of all on the production of a circuit drawing, which is not merely a wiring diagram but an actual drawing in black and white, showing precisely the metal pattern required.

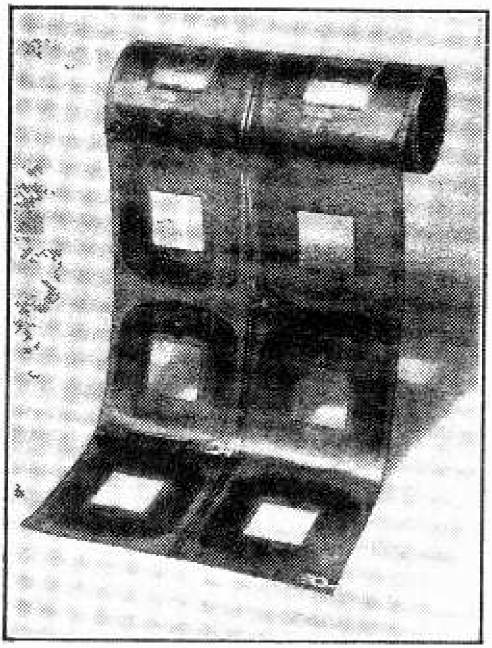


Fig. 5.—A printed transformer winding. Such patterns can be produced in the form of a reel, from which can be cut any desired number of coils in order to increase the inductance.

This drawing is converted into a printing plate by the normal photo-mechanical process that is employed throughout the printing industry, and hence it is necessary that the drawing should be carefully finished to ensure sharp definition and clean edges in the etched circuit.

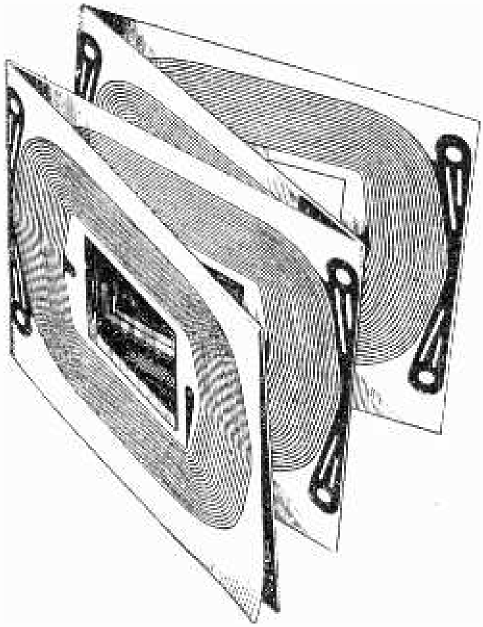


Fig. 6.—This illustrates the folding stages employed to connect the flat strip circuit into pile form, with the centre punched out to take the core. The individual coils are formed into a series winding by welding through the base.

The ink used to make the circuit imprint is formulated with special reference to the kind of metal being used, because it is this ink imprint which forms the resist during the etching stage, and obviously a different etch solution will be necessary for treating copper, silver, and so on.

The printing operation then follows conventional practice, except that special care is necessary to ensure that the inked image is absolutely free from pinholes or other flaws that would permit the etching solution to pass through to the metal which should be protected.

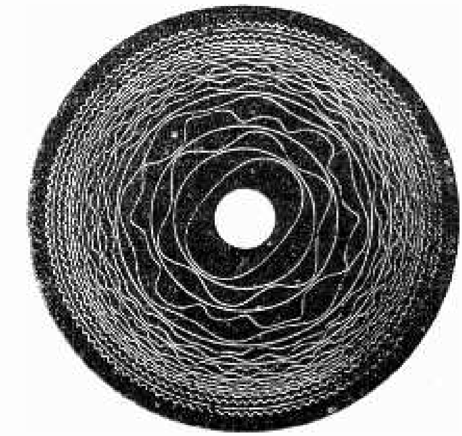
The Etching Process

While the general principles of etching are widely understood, there are nevertheless certain special considerations which apply when electrical circuits are to be etched.

Normal requirements do not entail etching completely through the metal as is needed when a sheet of foil is to be converted into a pattern of separate conductors, nor do the factors of " undercut " and sharp definition, which are all-important in fine-line electrical patterns, play any vital part in usual practice, but these factors become very critical when making closely spaced inductive coil circuits and other patterns such as strain gauges, resistors, etc., and there is, therefore, a great deal of specialised " know how " in the Technograph technique which permits foil to be etched into coil patterns as fine as 100 lines to the inch.

It will be realised that in thus creating a circuit from a solid sheet of foil much of the foil will have been dissolved into the etch solution and if this were merely thrown away the final cost of a printed circuit would be too high to be of practical value, and, moreover, as the initial cost of the etching solution is high and it soon becomes exhausted, there is a definite need to recover the dissolved metal and reconstitute the solution.

In the Technograph process this is achieved by a method which recovers the metal in the form of reusable foil, and at the same time restores the solution so that it can be used over and over again. When the etching of the printed pattern has been completed it only remains to remove the ink imprint by means of solvents and neutralise against all etch residues.



Figs. 7 and 8.—Left, the connecting wires are led through the base and joined to the wave form pattern. Right, printed and etched wave form for use as the stator in the Compton electronic organ. The black portions represent the copper.

The Use of Printed Circuits

As was stated earlier, there are some types of "printed" circuits that can be used only within limited spheres, but the etched foil circuit appears to have an extremely wide field of usefulness because it not only offers the very valuable facility of being able to use all kinds of metal in conjunction with all forms of insulator but it suffers no limitation in the matter of patterns.

When such circuits are used to replace the wiring of a radio receiver, a television receiver, or such-like instruments, it is still necessary to use the conventional types of components such as resistors, capacitors, etc., and these are attached to the printed circuit by merely soldering on to the etched pattern in the normal manner.

What is so interesting about this technique is the quite obvious possibilities it offers of new approaches to many difficult problems. For example, the Technograph firm have recently begun to market an entirely new form of resistance strain gauge which has aroused world-wide interest, not merely because these gauges are found to be far more sensitive than the conventional types but also because they eliminate all the mechanical difficulties associated with those types.

Slab Potentiometers

Another instance is the production of slab potentiometers, which hitherto have always presented difficulty, but which offer no problems to the Technograph process. Specialised circuits have been made which incorporate printed microfuses, as well as individual fuses for other uses.

But perhaps the most attractive possibility opened up by the Technograph patents is that of flexible circuits, which allow a fully assembled circuit to be folded up. This is made possible when circuits are formed on such flexible insulators as polythene or polystyrene films, impregnated paper or cloth, woven glass fibre, rubber films, etc.

This property of foldability can be of great value in the production of ultra-miniature assembly, motor and transformer windings, TV deflection yokes, heating applications, and in general a whole range of electrical purposes. In fact, the indications, particularly in American industry, show that this British process, invented and developed by Technograph Printed Circuits, Ltd., is a fundamentally new approach which may have a very important part to play in electronic developments.

Figs. 1 to 3 show the two parts of a folding circuit made on paper impregnated with phenolic resin, with the conductor pattern formed from tin-foil of .001in. thickness.

The dimensions of the smaller panel are 7⅝in. × 3⅜in. at widest part, and those of the larger are 7⅝in. × 6⅞in. at widest point, both in the unfolded position as photographed.

The idea of such folding circuits is that complete assembly of all components is done while the circuits are spread out flat, and then the whole assembly is folded together and inserted into the case or container.

In the circuit illustrated the two parts of the circuit are superimposed one above the other, with interconnections formed by making incisions at appropriate points in the upper layer and turning a small tongue of the incised conductor of that layer underneath so that it contacts a particular conductor in the lower layer.

News from the Clubs

MIDLAND AMATEUR RADIO SOCIETY

Hon. Sec.: G. W. C. Smith (G3HDK,) 84, Woodlands Road, Birmingham, 11.

THE success of the joint Jubilee Dinner of the M.A.R.S. and Slade Radio Society, held on Saturday, October 25th, was assured when the guests of honour were the Lord Mayor and Lady Mayoress of Birmingham, Alderman and Mrs. W. T. Bowen. The Lord Mayor responded to the toast of the City of Birmingham, which was proposed by Mr. E. C. Naylor-Strong. Other notable guests included Mr. H. J. Dunkerley, Regional Controller of the B.B.C., who responded to the toast of the guests and visitors.

The Christmas meeting of the M.A.R.S. will include a mock auction, together with other activities in keeping with the festive season. There will be no lecture at this meeting.

CHESTER AND DISTRICT AMATEUR RADIO SOCIETY

Hon Sec.: N. Richardson, 1, Victory Villa, Newton Lane, Upton, Chester.

THE winter programme is now in full swing with morse and technical classes Monday nights at 7.30. Club meetings at 7.30 p.m. on Tuesdays. Future programmes are: Dec. 16th, Bran Tub: Dec. 23rd, no meeting: and Dec. 30th, New Plans for 1953 N.F.D.: Jan. 6th, 1953, Tape Recording Troubles, by G2YS. New members will be welcome.

THE EAST SURREY RADIO CLUB

Hon. Sec.: L. G. Knight, Radiohme, 6, Madeira Walk, Reigate, Surrey.

THE headquarters of this club have been moved to the Ex-Service Men's Club, British Legion H.Q., High Street, Redhill, where all future meetings will take place. New members will be most welcome. Club call sign G3ISR.

COVENTRY AMATEUR RADIO SOCIETY

Hon. Sec.: K. Lines, 142, Shorncliffe Road, Coventry.

THE society's night on the air on top band has recommenced, and takes place the second Thursday of each month at 8 p.m.

The 21st anniversary dinner will be held at the "Hare and Squirrel," Coventry, on February 27th. Tickets, price 10s. 6d., may be had on application to the Hon. Sec., K. Lines (G3FOH), 142, Shorncliffe Road, Coventry, or any committee member.

Meetings continue at the Y.W.C.A., Queen's Road, commencing 7.30 p.m.

BIRMINGHAM AND DISTRICT SHORT WAVE SOCIETY

Hon Sec.: A. O. Frearson, 66, Wheelwright Road, Erdington, Birmingham, 24.

ACTIVITY of the society continues at a high level. Talks, demonstrations, junk sales and discussions have been held during the last months. A visit has been paid to a large Birmingham newspaper house, where special interest was centred on teleprinting and picture transmissions.

All visitors and new members will be welcome to the usual meeting place, the Colmore Inn, Church Street, off Colmore Row, Birmingham, 2.

THE WIRRAL AMATEUR RADIO SOCIETY

Hon. Sec.: L. Roberts, 18, Croxteth Avenue, Wallasey, Ches.

THE annual general meeting of the society was held on October 8th, and revealed a very healthy state in both strength of membership and financial position. An almost completely new committee was elected and the various offices are now held by G3EGX as hon. sec., G2AMV as chairman, G3FRT as hon. treas., with G3CSG, G3AKW and G2FNI completing the committee. The society meets every other Wednesday at the Y.M.C.A., Whetstone Lane, Birkenhead.

EDINBURGH AMATEUR RADIO CLUB

Hon. Sec.: C. L. Patrick, 19, Montgomery Street, Edinburgh.

WEEKLY meetings are now being held on Wednesdays at 7.30 p.m. in Unity House, Hillside Cres., Edinburgh. Intending members and visitors will be made welcome.

WORTHING AND DISTRICT AMATEUR RADIO CLUB

The new secretary for 1953 is: Mr. R. Chidzey, 33, Bruce Avenue, W. Worthing.

MEETINGS are held at the Worthing Adult Education Centre, Union Place, on the second Monday in each month. New members are being looked for, and all who are interested in amateur radio will be welcome at the meetings.

Surplus Magnetrons

DETAILS OF THE CAVITY MAGNETRONS WHICH ARE NOW AVAILABLE

By E. G. Bulley

THESE valves are available upon the surplus market in limited types and quantities. They have, however, created a great deal of interest to those whose hobby goes farther than that of ordinary radio reception.

Cavity magnetrons were used during the last war in radar as generators of microwaves, that is to say, they were operated in the centimetre waveband. It can be said, however, that they are a development from the split-anode magnetron which originated as far back as 1928. The split-anode type is a development from the solid anode magnetron which was invented in 1921 or thereabout.

The construction of the split-anode type comprised a straight-wire filament and an equal number of anode segments; each segment, although insulated from the other, was operated at the same D.C. potential. Across each pair of anode segments an external tuned circuit was connected.

Magnetrons are classified as diodes and require an external magnetic field parallel to the axis of the emitting electrode, the purpose of which will be discussed later in this article. The cavity magnetron was developed in 1940 and utilises a solid copper anode block, in which a series of small holes and slots have been cut. These slots go off in a radial direction, thus coupling the smaller diameter holes to the large one located in the centre of the anode block, sometimes referred to as the cathode area.

The slots and the small circular holes form more or less a tuned resonant circuit, the former having a capacitive effect, whereas the holes have an inductive one. Thus, it can be seen that this type of valve has the tuned circuits built within, instead of requiring external tuned circuits as in the case of split-anode types.

Furthermore, these holes and slots form what is known as the cavity or cavity resonator, and the physical dimensions of such actually determine the frequency at which the magnetron will operate. The greater the number of radial holes and slots, the higher the frequency of operation.

Alternate segments in most cavity magnetrons are strapped together by means of copper wire, and this provides greater stability in operation, and a much improved output.

The emitter comprises an indirectly-heated oxide-coated cathode, this being located at ninety degrees to the cavities in the anode block and passes through the large hole into which the slots converge.

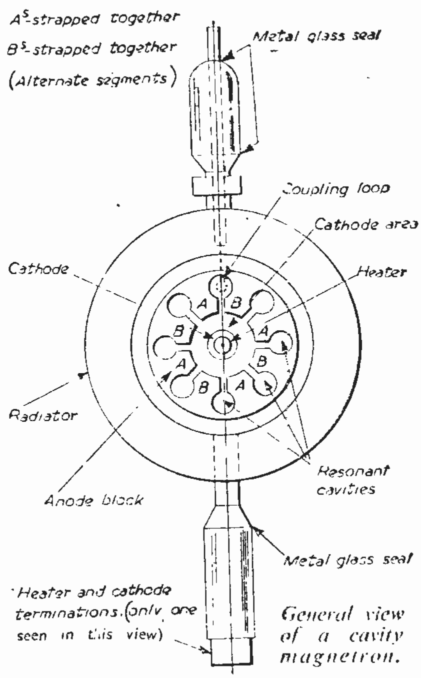
The R.F. output is taken from one of the cavities by means of a coupling loop; this loop projects into the cavity and is taken via metal/glass seals to the external circuitry. As mentioned earlier in this article, cavity magnetrons require a powerful magnetic field. This is accomplished by utilising a powerful permanent magnet, the magnet being so placed that the field is along the axis of the anode. Therefore, when the electrons are emitted from the cathode, their path to the anode segments is not straight but circular or curved, as they are influenced by the presence of electrical and magnetic fields.

It can therefore be said that the electrons flow to the anode (the latter being at positive potential) and are subjected to a force which tends to deflect them from the anode, thus causing the electrons to take a circular path and return to the cathode. This phenomena actually determines the frequency of operation because it is the time taken for the electrons to leave and return to the cathode, the cavities then being tuned to the frequency determined by this phenomena.

This condition enables the cathode to supply the intense emission required, thus creating an electro-magnetic field within the cavities, resulting in an oscillating voltage being induced into the coupling loop which in turn is transferred to a suitable waveguide.

The anode block is ribbed or has fins attached externally, the purpose of these being to assist in cooling. Another important point is that valves of this nature are so designed that they require forced-air cooling.

As a point of interest, another magnetron which is obtainable is that which is known as the "package type." This has the magnet as an integral part of the valve.



General view of a cavity magnetron.

THE AUDIO PROBLEM

A CONTROVERSIAL ARGUMENT WHICH REVEALS QUITE A NUMBER OF INTERESTING POINTS

AS readers will have noted from the correspondence columns and from various articles which have been published from time to time, one of the most difficult subjects for the average listener is the question as to reproduction. Should one build a 4-watt or a 15-watt amplifier? Can a simple loudspeaker give as good results as a multi-speaker assembly in a specially designed cabinet? Is a filter network or a cross-over network justified? These are only a few of the problems which beset some listeners and they may be justified in thinking that the subject is too involved to worry about.

First of all it is necessary to remember that there is a lot of unnecessary emphasis placed on the reproduction of broadcast programmes. Whilst it is true that the BBC endeavour to put out the very best quality, it is probably only those who are right close to the station and can use a limited-range quality receiver who can do justice to the programmes. Even then, there are many "experts" who say that the programmes or type of music which is put out do not justify any expense in the way of quality equipment. The reproduction of gramophone records or tape is another matter.

Loudspeakers

Taking loudspeakers first, is the installation of a multi-array justified in the ordinary home? First of all there is the question of mounting. If even only a single cone and a single tweeter are to be used they will have to be mounted side by side, and this means that sounds emanate from two different sources. If one is claiming to be a purist who wants absolutely the best, can he justify such an arrangement? Then again, if a tweeter is used to enable the highest notes to be reproduced, will the furnishings of the room permit those frequencies to be heard? Many a listener has gone to the expense of fitting up such an assembly, only to find that the results *sound* very little better than when a single speaker is used. Therefore, the reproducer must be chosen in relation not only to the type of room and its furnishings, but also according to the position the speaker will occupy in relation to the listener. Probably in most cases the use of a concentric type of speaker such as the W/B Stentorian, mounted in a good cabinet, which also houses the receiver and amplifier, will satisfy all but the most critical.

Amplifier

But to be considered in conjunction with the loudspeaker is the question of the amplifier. Is the expense of an outfit such as the popular Williamson, for instance, justified? This is certainly a very-high-quality amplifier with a really good response curve, but how many users of it can run it full out? Under normal domestic conditions the gain is probably turned down to half, and how many users have measured the performance when used in such a condition? As most readers know, the normal type of volume control introduces some distortion, but what is more important is the fact that as the volume of sound is reduced one's audio perception changes, and, unless a special circuit is adopted or tone controls are adjusted, one might as well use a normal type of amplifier at low volumes. In America the "loudness control" is gaining in popularity. This is a form of compensated volume control which aims at boosting bass as the volume is reduced, and this is done either with a specially built volume control or some form of circuit which acts automatically as the control is adjusted.

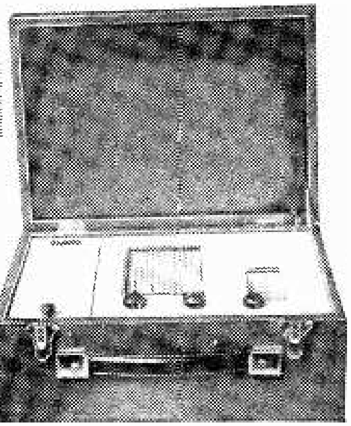
Mention of tone controls also brings in the question which is often being raised:—"Are they worth while?" What is the good of building a "straight-line amplifier" if tone controls are to be added to upset the response curve? One can say that individual items require compensation, but then where is "quality"? It means that that much used word merely stands for what suits the individual, and then we come to the most vital of all factors, individual hearing and appreciation.

Hearing Range

As we grow older our perception of the higher frequencies falls off, and, in addition, women can hear (in general) higher frequencies than men. Therefore, how can one design an outfit for domestic use when one of you can hear higher notes than the other. Surely, in the case of a husband and wife, the outfit cannot suit both. As a point of interest, the writer's cut-off, as tested with constant-frequency records, is just above 8,000 c.p.s., whilst the wife can hear well above 10,000. I am lucky (?), as I do not hear inter-station heterodyne whistles, but she can pick out cymbal rhythms, etc., which I have difficulty in discerning—therefore, if I had a tone control I would turn it up to emphasise the top whilst she would say it was too high-pitched. Even allowing that one built the equipment for one's individual use, there is still the question as to whether it is "straight line" or "fidelity." You might spend much money and labour in fitting up an amplifier and speaker arrangement which would eventually seem to you to be the very best that you had heard, and then a friend would come in and on hearing it would say, "Isn't it boomy," for instance.

To sum up, then, quality is what you make it, and is very largely a matter of individual preference, coupled with the conditions under which listening takes place. In my opinion there are very few listeners indeed who can do justice to a "less than so-many per cent. straight-line" amplifier, plus a multi-speaker in elaborate labyrinth type cabinets. For the music-club, where a special music-room is available, or for the larger house in which a room may be set aside for music, there is, of course, a different problem, and such equipment is then fully justified, but, as a matter of interest, next week-end choose a suitable programme (one that is not too short), and whilst it is on take up the carpet, and shift just the chairs out of the room and see, or rather hear, the difference.

A BATTERY-MAINS *Attache Case* PORTABLE



GENERAL FEATURES OF PORTABLE DESIGN AND A PRACTICAL CONSTRUCTIONAL FEATURE

By F. C. Warren

IT is the purpose of this article to describe the construction of this type of portable receiver generally, and in particular a model which can be easily built by the home constructor. A general view of this receiver as constructed is shown on our cover.

In designing an attaché-case receiver, the important considerations are weight and portability. Consideration of these points immediately leads to the choice of midget components and button-base type valves, and it has been found that if such components are used, there is ample scope for many variations of receiver design within a reasonable space.

In order to keep the cost down as much as possible, all the components suggested for use are of a standard, easily obtainable type.

The receiver can be either purely battery-operated or of the mains/battery type. Whilst the purely battery receiver can be built into a smaller space, and is, of course, slightly cheaper to construct, the addition of a built-in mains unit, with suitable switching for a quick change-over from mains to battery operation, or vice versa, brings many advantages. Whereas a purely battery receiver is only really economical to run out-of-doors, which means, of course, that its use is limited to the summer months in most cases, a mains/battery receiver can be used both out-of-doors and as a "transportable" receiver anywhere in the house, plugged in to a convenient power point, and used without imposing any drain on the batteries. It is felt that the slight additional cost of building the mains unit will soon be repaid by battery saving.

The Circuit

To turn now to the choice of circuit, the superhet is definitely to be preferred. Apart from the advantages of increased sensitivity and selectivity, the controls can be made few and simple, besides which the excellent series of button-base battery valves is available in the 1.4 volt heater type intended to be operated from all-dry batteries.

The theoretical circuit of the particular receiver to be described is shown in Fig. 1. and no claim is made to any particularly novel features. It may be noted that no A.V.C. circuit is shown. This was found to have very little effect on the performance of the receiver, but can easily be added if desired, and a suitable A.V.C. circuit is shown in Fig. 1(a). The receiver was constructed to cover the medium waveband only as this was felt to be adequate for most people. However, a long-wave range would be quite easy to add.

The circuit of a suitable power unit is shown in Fig. 2, which also shows the switching connections for changing from mains to battery operation, and vice versa. As will be noticed, this switch also serves as the "on off" switch for the receiver, being "off" in the centre position.

It was decided to build the power unit to give a 1.4 volt supply for the valve heaters so that these could be wired in parallel. This is to be preferred to the series-heater arrangement adopted in many commercial type mains/battery receivers, as with the latter type, where the heater voltage is derived from the high-tension supply, the risk of damage to the valves is greater. Of course, a power unit to supply 1.4 volt at 250 mA, such as is generally required, needs adequate smoothing, employing condensers of 2,000-3,000 μF., but since these need only be of 1.5 volt working they are both fairly small in size and reasonable in price.

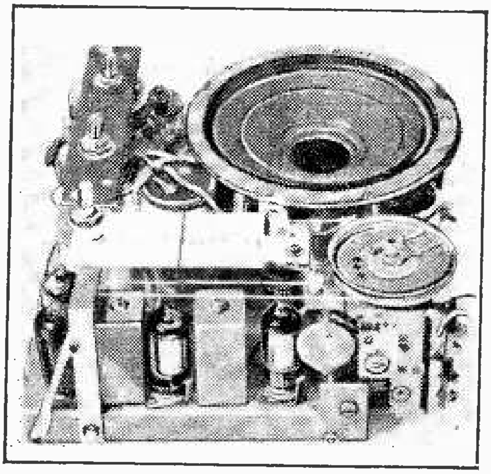
Many attaché-case portables incorporate some type of warning device so that the lid will not be closed whilst the set is being used; such a device was not included in the particular set to be described, as it was not considered really necessary.

However, some type of warning device can easily be added and may be of either electrical or mechanical form. The former type may comprise a condenser connected in series with a switch between the anode and grid of the output valve to provide a positive feedback path when the switch is closed, causing the output valve to oscillate and produce a "howl" in the speaker. The switch is closed upon closing the lid of the set, and, if the latter is still switched on, the warning howl is produced.

The mechanical warning device is much simpler and may consist of a notch cut in the on/off switch which co-operates with a projecting peg mounted inside the lid, so that when the switch is in the "off" position the peg fits in the notch when the lid is closed. If, however, it is attempted to close the lid when the set is switched on, the peg is not aligned with the notch and so prevents the lid from closing.

Constructional Details

The receiver was built in two units which are bolted together as one assembly. The first unit comprises the receiver proper and tuning drive, whilst the second unit comprises the loudspeaker and power unit, and also carries the control switch and volume control. These two units will now be described in detail.



Details of the chassis mounting.

The Receiver

The chassis for the receiver is shown in Fig. 3, and, as can be seen, this is of very simple form. It is pointed out that the dimensions given are purely by way of a guide, as it is appreciated that individual constructors may wish to make minor changes depending on the overall size and shape of the case in which the receiver is to be accommodated.

It should perhaps be pointed out at this stage that the complete receiver, power unit and batteries are intended to be housed in a casing, having the following internal dimensions: length, $10\frac{7}{8}$in., breadth $7\frac{5}{8}$in., depth $3\frac{1}{2}$in.; which is closed by a lid having an internal depth of $\frac{5}{8}$in., and which accommodates the frame aerial.

A good general view of the receiver in its case, with the battery compartment open, is shown on the right.

The chassis was made from duralumin sheet (about 20 gauge) and comprises a base portion of 5in. by $2\frac{5}{8}$in., with flanges of $\frac{5}{8}$in. depth turned down on its two longer sides. A suitable projecting portion of about $\frac{3}{4}$in. is provided at one end, and may be integral with the chassis or bolted to it, and forms the bracket to which the tuning condenser is fixed. The cut-out portion in the chassis extends for most of its length, and leaves a platform at the front end on which the detector/I.F. amplifier and output valves are mounted. An inverted channel-shaped support bracket positioned over this platform and having its lower ends bolted to the flanges of the chassis provides a bracket on which is mounted the tuning spindle and a pulley for the cord drive. Two support struts help to hold the bracket rigid. The first two valves of the receiver, namely, the frequency changer and I.F. amplifier, and the two I.F. transformers are mounted on the narrow rearward extension of the chassis alongside the cut-out. As can be seen from the illustration on the left, the tuning condenser is mounted with its spindle in a vertical position and is secured to the chassis, either by bolts tapped into holes in the condenser frame, or by bolts passing through holes in the frame and secured by nuts on the other side. As almost any type of midget tuning condenser is suitable, the precise method of fixing will vary from type to type. It is essential to mount the condenser on the chassis as rigidly as possible so that the tuning drive works efficiently.

It was decided to employ a tuning drive of the type having a horizontal cursor which moves over an elongated scale, since, although this is more complex to construct than the normal type employing a pointer moving over an arc of a circle, the resulting appearance is much more pleasing and it

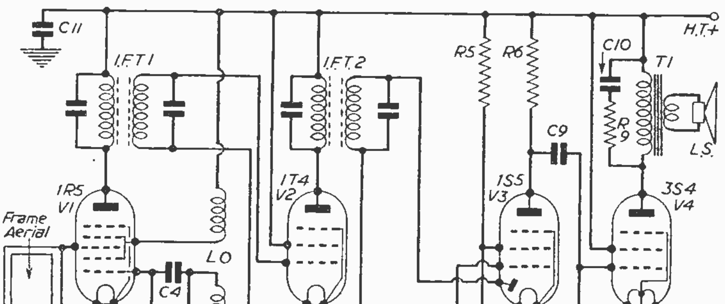


Fig. 1.—Theoretical circuit of the receiver.

LIST

RECEIVER

C1, C2 — 0.0005 μF. approx. midget twin gang (with trimmers).
C3—500 pF. preset.
C4—100 pF.
C5—100 pF.
C6—100 pF.
C7—0.002 μF.
C8—0.1 μF.
C9—0.01 μF.
C10—0.005 μ
C11—0.5 μF.
C12—0.1 μF.

R1—47 KΩ
R2—100 KΩ
R3—1 MΩ variable.
R4—10 MΩ
R5—2.7 MΩ
R6—1 MΩ
R7—2.2 MΩ
R8—680Ω
R9—3.9 KΩ

V1—1 R5
V2—1 T4 or 1L4
V3—1 S5
V4—3 S4
} or British equivalent

T1—Battery pentode output transformer.
IF1, IF2 — Wearite miniature type 460 Kc/s.

also enables a neater form of scale to be used.

In order to secure the cursor at either end to the drive cord it is necessary to arrange the cord so that there are two parallel spaced lengths of cord moving in the same direction at the same speed. This is achieved by the arrangement shown in Fig. 4, where it can be seen that the cursor is attached to the portions A and B of the cord. The cord drive is used in conjunction with the normal type of drum drive and separate tuning spindle, the drum being mounted on the spindle of the tuning condenser and the tuning spindle being mounted on the front support bracket. Two small pulleys are also needed, as shown in Fig. 4, one being mounted on a bracket fixed to the frame of the tuning condenser and the other being mounted on the front support bracket. It is possible to buy suitable small pulleys, but, alternatively, they can easily be made from short pieces, about ½in. long, of dural or brass tube or rod. If rod is used it is necessary firstly to drill a central

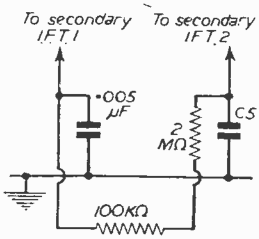
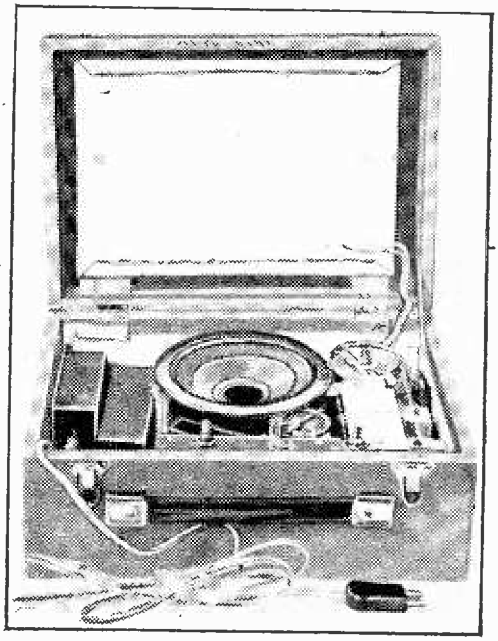


Fig. 1(a).—Suitable A.V.C. modification.

hole of 6 B.A. clearance. A simple method of cutting the groove on the sides of the rod, to form the pulley, is to slip a suitable length of rod on a 6 B.A. bolt and secure it against the head of the bolt by means of a lock-nut. The free end of the bolt is then mounted in the chuck of a hand-drill which is clamped in a vice with the chuck horizontal and the handle uppermost. If the handle is now turned with one hand and the edge of a small file held against the side of the rod with the other hand, a fairly accurate groove can soon be cut in the rod. It is easier if one end of the file is rested against a support whilst it is being held against the rod.

Although this method may sound somewhat primitive, it does produce a satisfactory result when only the usual hand tools are available.

The pulleys are mounted on spindles which are formed by 6 B.A. bolts of suitable length passed through fixing holes on the supports and locked by means of a nut. The pulley is then slipped over the bolt and two nuts screwed on to the bolt after it,



Another view of the portable.

OF COMPONENTS

LO Wearite PO2
5in. P.M. loudspeaker (W./B.).
3 Midget knobs (Bulgin).

POWER UNIT

C13—30 µF. 150 v.w.
C14—30 µF. 150 v.w.
C15—2,500 µF. 1.5 v.w.
C16—500 µF. 12 v.w.
MR1—100 v. 10 mA. Selenium type.
MR2—6-12 v. full wave 250 mA. Selenium type.
R10—1,000 Ω—1 watt.
R11—15Ω—vitreous.
T2—230 v. primary secondaries : 0-90 v.—10 mA. 8-0-8 v.—250 mA.
S1—S4—4-pole, 3-way Yaxley type.

CASE

½yd. leather-cloth 48in. wide.
2 Snap clasps chromium plated.
1 Lay-flat handle.
2 1in. hinges chromium plated.
1 1¼in. hinge chromium plated.

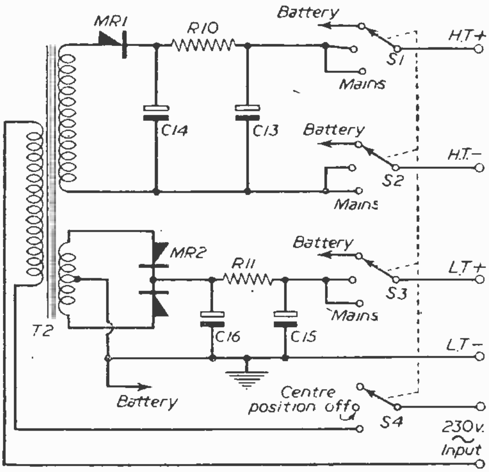


Fig. 2.—Theoretical circuit of the power pack and switching.

which are locked together to form a stop, leaving sufficient clearance between the inner nut and the pulley for the latter to rotate. Any projecting outer end of the bolt can be cut off.

The cord is preferably nylon cord, such as is sold specially for tuning drives, and its method of attachment will be clear from Fig. 4. The usual tension spring is provided at one end of the cord and anchored to the drum to hold the cord taut and allow for stretching. The cursor is fashioned from a piece of stout wire—of about 20 s.w.g. to the shape shown in Fig. 4 so that the hooked ends grip the cord. A satisfactory cursor can be easily formed from a straightened paper clip.

As can be seen from Fig. 4, a strut, which can be

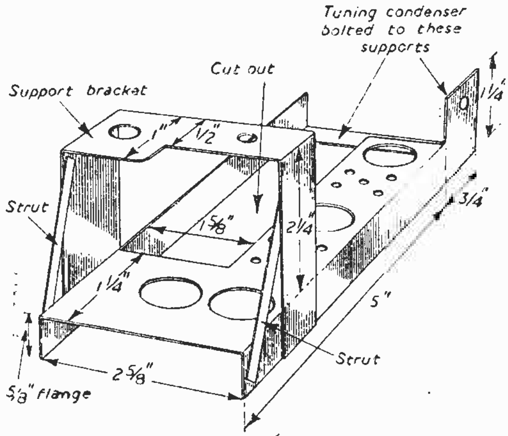


Fig. 3.—Details of chassis.

simply a flat piece of scrap metal, is secured between the front support bracket and the frame of the tuning condenser to increase the rigidity of the assembly. This strut also forms a support for the scale, which is made from stout card or Bristol board. The making and marking of the scale will be described later on, under the lining up and operation procedure. An end view, showing the tuning spindle and neighbouring pulley on the support bracket is shown in Fig. 5.

It may be found that the travel available for the cursor is not sufficient to allow the condenser plates to swing completely through 180 deg. However, this is of minor importance since with the small type of tuning condenser used and a normal medium-wave coil the minimum capacity of the condenser is so small that the set will normally tune well down below 200 metres. For example, in the set constructed by the author the tuning range is from about 480 metres down to about 150 metres, and this is with the tuning condenser not quite fully open at the high frequency end. The exact waverange will, of course, depend on the condenser used, but adequate coverage of the medium waveband can always be obtained.

Assembly

Most of the components are mounted in the wiring under the chassis, and no particular layout is followed,

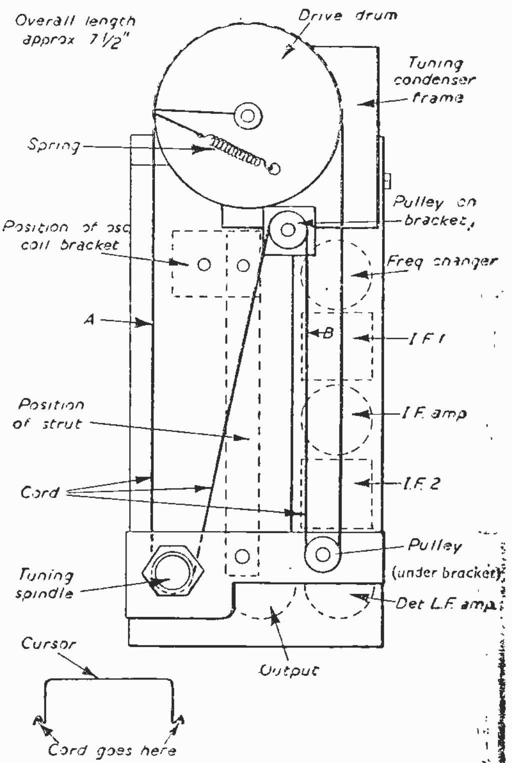


Fig. 4.—Dial drive and cursor details, with location of main components.

as, owing to their small size and the fact that they are relatively few in number, they can easily be accommodated. The usual policy of keeping components close to their associated valve base is followed. As the preferred I.F. transformers have all their connections under the chassis, and the valves are all single-ended, it is not necessary to bring any leads through the chassis. A general view of the chassis is shown in the illustration at the top of page 28. The oscillator coil, which is a Wearite type PO2, is mounted in an inverted position from a second small bracket fixed to the tuning condenser. This is a convenient position close to the tuning condenser and frequency changer valve, and since the coil is mounted upside down its tags are near the valve pins of the

(*Continued on page 33.*)

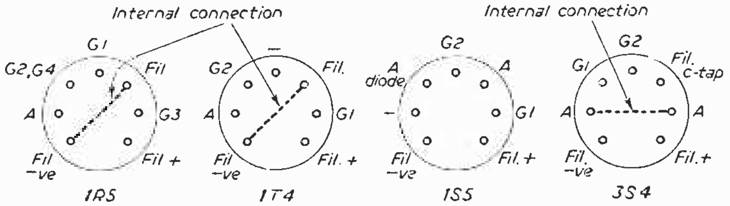


Fig. 2 (a).—Valveholder connection details.

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Consists of metal front panel on which is mounted 2 large 4 BA terminals, 1 red warning lamp, 1 large P.O. 4-way jack, 16-way SP/switch, 1 rotary ON/OFF switch, 1 single crystal holder. On a sub-chassis, which is shock mounted, are 3 4-pin valveholders, 6 crystal holders, 2 condensers, 1 choke, 1 transformer, 2 coils, plus numerous small condensers and resistors. Housed in a plastic case 7½ x 5½ x 3½in. In transit case.

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Resistance 20 ohms 1.5 amps.
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for 200/250 volts

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E63 B9G (EF50) Loctal, Ceramic **1/-** each, post 1½d.
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Twin-gang and Pair of L. and M. T.R.F. Coils with circuit to suit above. **8/6.**

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Valveholders. Paxolin octal, **4d.** Moulded octal, **7d.** EF50 ceramic, **7d.** Moulded B7G slightly soiled, **6d.** Loctal amphenol **7d.** Loctal pax: **4d.** Mazda Amph : **7d.** Mazda pax : **4d.** B8A, B9A amphenol **7d.** B7G with screening can **1/6.**

Trimmers. 5-40 pf., **5d.** ; 10-110, 10-250, 10-450 pf., **10d.**

Twin-gang .0005 Tuning Condensers, 5/-. With trimmers, **7/6. Midget** .00037 dust cover and trimmers, **8/6.**

P.M. SPEAKERS	with trans.	less trans.
2½in. ...		15/6
3½in. ...		13/6
5in. ...	16/6	12/6
6½in. ...	16/6	13/6
8in. ...	18/6	15/-
10in. ...		25/-

Post and packing on each of the above, 1/- extra.

Crystal pick-up with Sapphire Trailer Needle, 21/- each ; with volume control, **23/-** ; post and packing on each, 1/-.

Constructor's Parcel, comprising chassis 8in. x 4in. x 1½in., with speaker and valveholder cut-outs, 5in. P.M. speaker with transformer, twin gang with trimmers, pair T.R.F. coils long and medium, iron cored, four valveholders, 20 K. volume control and wave-change switch. **23/-**, post and packing 1/6.

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Output Transformers. Standard type 5,000-ohms imp. 2-ohms speech coil, **4/9** ; Miniature type 42-1, **3/3.** Multiratio 3,500, 7,000 and 14,000 2 ohms speech coil, price **5/6.** 10-watt push-pull 6v6 matching 2 ohms speech coil, **7/-.**

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Mains Trans. Pri., 200-250 v. Sec. 3, 4, 5, 6, 8, 9, 10, 12, 15, 18, 20, 24 and 30 volt at 2 amps., **13/-.** P. & P., 1/6.

300-0-300 100 mA., 6 v. 3 amp., 5 v. 2 amp., **25/-.**

Drop-thro', 350-0-350 v. 70 mA., 6 v. 2.5 amp., 5 v. 2 amp., **14/6.**
280-0-280, semi-shrouded drop-through, 80 mA., 6 v. 3 amp., 5 v. 2 amp., **16/6.**

Semi-shrouded, drop-through, 280-0-280, 80 mA., 4 v. 6 amp., 4 v. 2 amp., **12/6.**

Auto-wound. H.T. 280 v. at 260 mA., 4 v. 3 amp., 2 v. 3 amp., or 6 v. 3 amp. Separate 4 v. 3 amp. rectifier winding (upright or drop-through), **10/6.**

350-0-350, 120 mA., 4 v. 4 amp., 4 v. 3 amp., drop-through, **21/-.**
Auto-transformer, various combinations of voltages including 110 v. 70 watts, and 3/4 v. windings at 1 amp., 2 v. 1 amp., drop-through or upright mounting, **10/6.**

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250-0-250, 80 mA., 6 v. 4 amp., **14/-.**

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(*Continued from page* 30.)

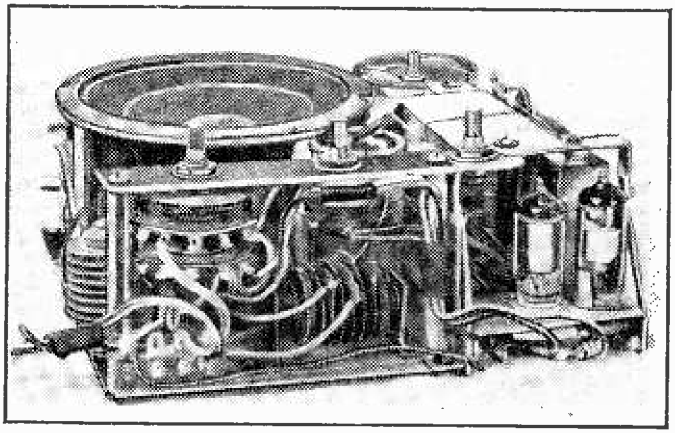
frequency changer and the leads can be kept nice and short.

The frame aerial, which is accommodated in the lid, is very easy to make and will be shown in Fig. 7. As can be seen it is wound on a stout card of approximately 9½in. x 6½in. having diagonal slots cut in each corner, and the wire is simply wound round the card in the slots. The aerial was wound with 30 s.w.g. enamel wire and for a Wearite PO2 oscillator coil about 15 turns is required. However, it is suggested that if about 20 turns are wound on in the first place, the frame aerial can be accurately matched to the set, as will be described later. When finally completed, the ends of the aerial winding are soldered to tags passed through the cardboard, to which the connectors from the receiver are also soldered. The winding itself may be covered with strips of "Cellotape" to hold it in position against the card. Although the frame aerial only comprises a single winding, it gives excellent results.

The Power Unit

The chassis for the power unit comprises a rectangular sheet of metal approximately 7½in. x 5in. The loudspeaker, volume control and switch are also mounted on the chassis. At the front edge of the chassis a metal strip, on which the volume control and switch are mounted, is arranged on two stand-off pillars secured to the chassis by 4 B.A. cheese-headed bolts threaded into holes tapped in the pillars. The speaker is also mounted on our similar stand-off pillars again fastened to the chassis by 4 B.A. cheese-headed bolts. The use of cheese-headed bolts raises the chassis plate slightly from the base of the case and provides a clearance for other nuts and screws by which components are mounted on the chassis plate. The stand-off pillars are made of such a length that the metal strip carrying the volume control and switch is at the same height as the front support bracket carrying the tuning spindle on the receiver, and is arranged so that all three controls are in line when the power unit is bolted to the receiver; which is achieved by means of brackets secured to the adjacent flange of the receiver chassis.

A 5in. speaker is employed, with the speaker transformer mounted on its frame in order to save space on the chassis. The stand-off supports for the speaker are made of such a length that the top of the speaker is approximately level with the plate carrying the controls. Almost any permanent magnet speaker is suitable, particularly the light-weight types. The various components forming the power unit are grouped around the speaker, see Fig. 8 which will be given next month. The large tubular condensers forming the H.T. and L.T. smoothing are mounted adjacent to the stand-off pillars of the speaker, and held by metal straps passing round the pillars. The two rectifiers for H.T. and L.T. are mounted on the chassis plate, as is also the mains transformer. The smoothing resistors for H.T. and L.T. are mounted in the wiring. A small tag strip is also mounted on the chassis under the switch, and used as the terminal strip for the mains input lead.



An interior view of the receiver.

A word on the L.T. smoothing circuit will probably be helpful. The reservoir condenser used was of 500μF, 12-volt working, and the smoothing condensers comprised two 1,250μF units, rated at 1.5 volts "audio frequency." These condensers are Government surplus and the peculiar thing about them is that they appear to be of reversible polarity—as no polarity is marked on them, and they hold a charge efficiently in either direction! If condensers of this type cannot be obtained, there are suitable condensers of 2,500μF, 3-volt working, on the market by the usual condenser manufacturers, and the use of one of these will result in some saving in space.

The Mains Transformer

This was constructed from an old speaker transformer, the primary winding being used as the primary of the mains transformer. In order to ensure that the proposed speaker transformer was suitable for use on mains, its primary insulation was tested first, and as the transformer was wound on a bakelite former with end cheeks this was satisfactory.

(*To be continued*)

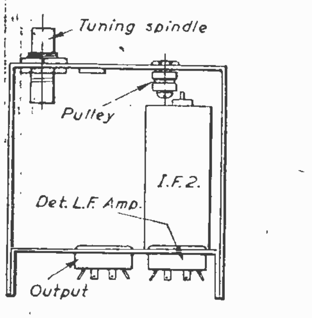


Fig. 5.—Further details of dial drive.

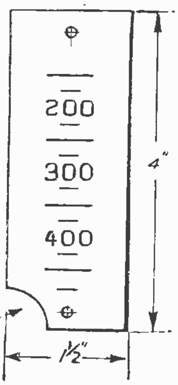
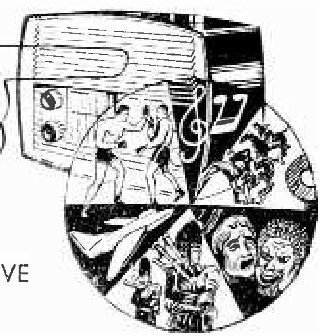


Fig. 6.—Dial details.

Programme Pointers



By
MAURICE REEVE

A Best-seller

I SUPPOSE the chief radio event of the past month has undoubtedly been "The Struggle for Europe," a "radio-isation" in four programmes of an hour's length each of Chester Wilmot's best-selling book of the same title. Produced by Laurence Gilliam and excellently narrated by the author himself, "the diplomacy and strategy of the Second World War"—according to the note in the *Radio Times*—"are re-examined in an attempt to discover why Germany was defeated and how Russia became the predominant power of Europe."

Although I offer two major criticisms, let me say straight away that for one listener at any rate, "The Struggle for Europe" formed an exciting, dramatic and absorbing series of broadcasts.

The criticisms? First, the book. Naturally, it is outside my province to write of it as either a literary critic or a politician. Consequently, I refrain from doing so, great though the provocation is. But I would like to observe that, as many modern thriller-writers do, who first think out an original new killing and hiding-place for the body, working backwards and outwards, as it were, and finishing where most other storytellers would commence, Mr. Wilmot has similarly re-traced his steps from the world which confronts him to-day back to the one we all left behind us in 1938, when the story began. I doubt very much whether he could have begun to forecast, fourteen years ago, the pattern of human destiny as it has so tragically unfolded itself. But whether this, if correct, detracts from the merits of "The Struggle for Europe" as a book, I will not try to say. It did not detract from it as it unfolded itself as a series of programmes. The labour involved in its compilation is frightening, and the author must be congratulated on having gathered together a collection of speeches, documents, minutes, off-the-record asides, and what you will, that will remain of the utmost historical value, apart from the conclusions arrived at.

And, secondly, the presentation. With the exception of the characterisation of Hitler, every single participant, whether speaking in the moment of greatest military victory or direst disaster, whether in political triumph or frustration, whether at home or abroad, in public or in private, in sickness or in health, spoke as though he were delivering the funeral oration at Gladstone's obsequies. While Hitler, as always, ranted, screamed and "carried on" like any spoiled child who does the same when it can't get what it wants, which is always, as it never wants the same things for five minutes running. He sounded precisely the same when revelling in what he considered overwhelming triumph in 1940 as he was in overwhelming defeat five years later. But no scope for acting or portraiture is allowed in these documentary programmes: a "personality" is rigged up for Hitler, Churchill, Roosevelt, Stalin, etc., and the cast just reads or says its lines within that framework, whatever the context. It seems a pity more variety cannot be imparted to the proceedings. The actor playing Roosevelt was the great president to the life.

Plays

Not far behind in importance must be ranked the plays being given on Mondays and Saturdays in a series styled, "English Theatre, 1900-1950." It is providing some capital entertainment. Some of the selections of Mr. J. C. Trewen seem of rather doubtful vintage, but examples like Richard of Bordeaux, The Mob and The Silver Tassie, are examples of which any theatre can be proud.

Variety

The current variety programme on Saturday evenings, under the title of The Star Show, is a great improvement on its un-lamented predecessor Music Hall. It only goes to show the importance of production because a glance at the programme would not seem to portend any change in type or style at all. But there is, a great deal. And an important and improving one is that most of the turns are shorter. The whole thing, in fact, is so much better that we hardly notice it runs for a quarter of an hour longer than Music Hall did, which is saying something.

"The Archers"

I have seen "The Archers" described as radio's number one show; the most popular item in current programmes. Incredible as this may be, if true, I accept it as a fact. By the "most popular" I presume is meant that it attracts the largest number of listeners. If it succeeds in doing this, it should be in less need of a repetition than less fortunate features. Consequently I fail to see why a whole hour, in the busiest part of the Saturday evening programmes, should be given over to a complete re-capitulation of this whilom and erstwhile farming family's doings of the five previous evenings, which themselves are featured at the hour most calculated to draw the largest audiences.

"In All Directions"

In common with most others, I was enchanted with the first of the Peter Ustinov-Peter Jones programmes, "In All Directions." But I do not think any of the three subsequent ones I heard came anywhere near it. The search for Copthorne Avenue is already tedious. The concerto for piano and orchestra in the note C, in the first issue, portended delights which have not so far materialised.

Among the events, the memories of which the younger generation were commended by their elders to take with them into their own old age, were the two concerts given by the 85-year-old Toscanini.

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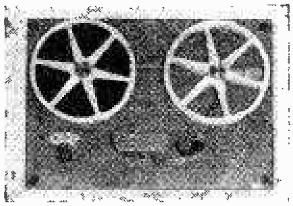

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TRANSMITTING TOPICS

CENTRE-LOADED AERIALS

By O. J. Russell (G3BHJ)

FOLLOWING upon the "Aerial Ideas" that have previously appeared, it seems opportune to discuss further aerial points which can make life more tolerable for the city-bound amateur with very restricted space at his disposal. Naturally enough, space restrictions are felt most keenly upon the top band and upon 80 metres, and further pointers concerning these bands are in order.

As previously discussed, the compacted aerials in which the feeder system is included in the "resonant length" are very useful in obtaining an efficient radiating system for the L.F. bands that can be accommodated in very restricted spaces. The "bent" system, shown in Fig. 1, is also very useful (particularly if combined with the compacted aerials utilising the feeders as part of the total resonant lengths), as by hanging part of the wire down at the ends, as much radiating wire as possible is included in a restricted "run." Thus, if the clear "run" of top length is, say, 30ft., and if the aerial itself is raised some 20ft. above the ground, then the two hanging lengths can each be 20ft. long. Thus the total radiating wire section will actually be some 70ft. To make up a system having a fundamental resonance in the 80-metre band, a total system length of 132ft. is required, and, as previously explained, this can be achieved in the present example by centre-feeding with 31ft. of spaced feeder. Incidentally, 300 ohm moulded line is quite effective in these compacted systems as the feeder, while spaced feeder of the open-wire type is also suitable. It is hoped that as a result of discussions with manufacturers, a new type of feederline will be made available for amateur use, which will be equally suitable for tuned systems and also for the "matched impedance special" recently described in this magazine.

However, there is another interesting point about the "bent" aerial of Fig. 1. The design enables more of the "best part" of the aerial to be arranged in the clear. To explain this, it should be noted that "the best part" of a transmitting aerial is the part at which current is highest. As is well known, with a half-wave aerial, bending down the last few feet of the radiating top portion has very little effect indeed on performance.

"Loading"

It is intended to stress the fact that the "high current" part of an aerial are the parts from which radiation is greatest, as this is very important in the consideration of Marconi type aerials. The use of a short length of wire "loaded" up as a Marconi system is well known (Fig. 2). However, as the amateur with restricted space who wishes to operate the top band has to use a "short" length of wire, that is a length of wire shorter than a quarter-wave-length, then a large amount of "loading" inductance has to be added in order to resonate the system. Unfortunately, the "high current" part of the aerial has in effect disappeared into the coil, while the part that is left represents the relatively less effective end portion of the aerial. It is perfectly legitimate to regard a coil-loaded aerial as derived from a long aerial by winding the "surplus" length into the loading coil. This is illustrated in Fig. 3, where it will be seen that the coil-loaded aerial of the Marconi type has to utilise the "poorest" of low current portion of the aerial as the actual radiating portion.

The above considerations reveal that there are quite

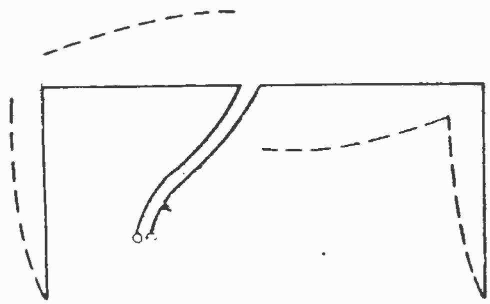
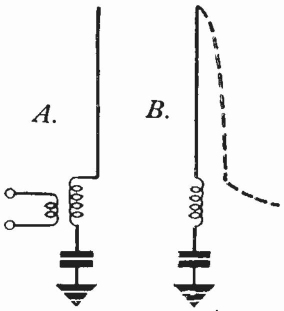


Fig. 1.—"Bent" antenna. The current distribution (dotted lines) shows that the high current portion is in the centre. Little loss results from allowing the ends of the antenna to hang down, as their contribution to radiation is relatively slight.

a few reasons why really good top-band results are difficult to get, particularly when space is limited! As readers will be aware, there is also the problem of securing reasonably low earth losses. However, there is a ray of hope. Clearly, as Fig. 3 shows, we have "wound up" all the high current parts of our aerial into the loading coil, so that we are forced to use the low current part of the radiator. Supposing, however, we wind up the low current part into a coil, and retain the high current part as a radiatior? In effect, this is the object of the "centre-loaded" aerial shown in Fig. 4. By inserting a loading coil in the



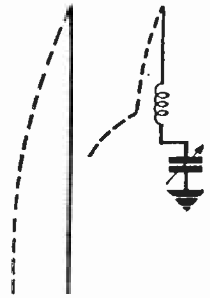


Fig. 2 (left).—"Marconi" type antenna (A) and the current distribution diagram (B). The high current portion is no longer on the aerial itself, but has "disappeared" into the loading coil.

Fig. 3 (right).—Comparison of the quarter-wave element, with the Marconi tuned with a loading coil, showing how the most effective radiating portion of the antenna is lost by end loading.

centre of the radiating portion, we find that the base loading coil required at the station end becomes much smaller in size, and part at least of the higher current portion is transferred to the actual radiating aerial. In this way a considerably more effective radiating (and receiving) aerial for top band use becomes feasible. In fact it is possible, by loading coils used in this fashion, to make a short vertical whip aerial an efficient top band radiator. Aerials of this type are in fact very popular in the U.S.A. for mobile transmission work on 80 metres and the top band, as the loading coil system converts a very poor radiator of the short whip type to a reasonably effective radiator. Applied to rather longer aerials, a correspondingly greater improvement can be expected.

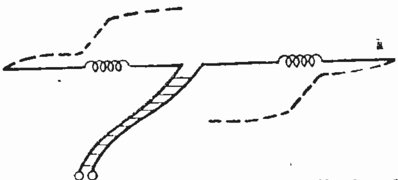


Fig. 4 (left).—A loading coil placed in the centre of a Marconi type system, enables some of the valuable high-current portion to be produced on the radiating wire, thus improving operation. Fig. 5 (right).—A short centre-fed antenna can be centre-loaded so as to provide effective topband operation.

Centre-loading

The amateur with restricted space facilities will find a little experimenting with "centre" loading coils will be very well rewarded. The writer, in fact, has had good results on the top band with a 20ft. aerial with a centre-loading coil. A point deserving of attention, however, is that the insulation of the coil should be very good, as quite high voltages may be developed across it, particularly if a large coil is used to resonate a short aerial. Some form of protection against the weather is necessary so that damp and rain are kept from the coil. A practical limit is reached round about the point when the total length of wire wound into the coil equals the length of wire necessary to provide a quarter-wavelength in conjunction with the wire already used in the aerial, and in many cases less wire than this can be used. In any case the size of coil required to improve a short aerial is not critical, as starting with a small coil, improvement in performance increases with coil size until the whole system approaches a fully resonant condition. The amateur who already has a short Marconi type wire can experiment cautiously by progressively increasing the number of turns of a loading coil inserted into the centre of the wire. It will be found that the loading conditions at the series-tuned loading circuit at the station

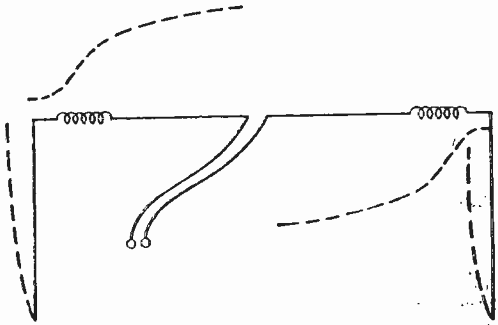


Fig. 6.—Combination of centre-loading with the "bent" antenna. This makes the most use possible of limited space.

end will then require less and less inductance at the aerial tuning network. In fact, it is possible to load beyond the series position and arrive at a heavily loaded wire which will actually prefer a parallel-tuned circuit at the aerial tuning unit! However, as with most things, judicious moderation will be found more effective. In other words, if the centre-loading coil is made unduly large, the losses of the centre-loading coil also become unduly large, so that no further advantage is gained. By the same token, a low-loss construction coil wound with heavy gauge wire on a low-loss former is preferable. For obvious reasons a large coil will also be heavy which also places a practical limit upon the amount of centre-loading feasible in given circumstances. For these reasons, therefore, the above factors provide for an intriguing amount of useful experimentation by the amateur determined to obtain the maximum efficiency under difficulties.

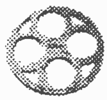
Finally, there is absolutely no reason at all why the above principles of centre-loading should not be applied to aerials of other than the Marconi type.

(*Concluded on page 50*)

SOUND RECORDING?

these are your accessories

Recording Tapes



A complete range of recording tapes is available and the following can generally be supplied from stock. Simphonic Grade "A" High coercive tape, per 1,200ft. spool, 35/-. Simphonic Grade "B" Medium coercive tape, per 1,200ft. spool, 25/-. G.E.C. Grade "A" tape, per 1,200ft. spool, 30/-. E.M.I. Grade H65A Low coercive tape, per 1,200ft. spool, 35/-. E.M.I. Grade H60A High coercive tape, per 1,200ft. spool, 35/-. Scotch Boy Grade MC1-111 tape, per 1,200ft. spool, 35/-.

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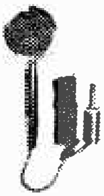
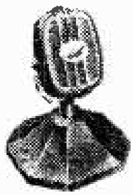
Microphones



The microphone illustrated is the standard one supplied with the Simphonic 2B Recorder. It is a crystal type hand microphone, and has a particular appeal because it is ideally suited for speech applications with small recording equipments. Chief characteristic is its high sensitivity at comparatively low cost. Complete with 9ft. screened lead and jack plug, £2/10/-.

Type DML



Recommended for use where a higher standard of quality than is obtained with the crystal type is demanded. Useful as a general purpose microphone for Public Address work as well as many other applications. Sensitivity approximately the same as the crystal type, and this microphone has a substantially even frequency response up to 6,000 cycles. Complete with heavy cast base, 9ft. screened lead and jack plug and with built-in transformer and muting switch, £7/5/-.

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Magnetic Braking in Tape Recorders

AN INTERESTING SWITCHING IDEA FOR THE RECORDING ENTHUSIAST

By Alfred Thomson

WHILST constructing a magnetic tape recorder, the writer was faced with the problem of braking the reels to bring the mechanism to a quick stop. A mechanical system, using felt-lined shoes which bore against the reel holder hubs was fitted. This proved inefficient owing to the two reels not braking simultaneously, with the result that the tape got broken or else the tape was inclined to throw out. Attention was then directed to applying a method of magnetic braking. The principle is to disconnect the A.C. supply to the motors and apply a direct current supply to them, which when applied to the windings of a four-pole induction motor will bring the armature to a stop.

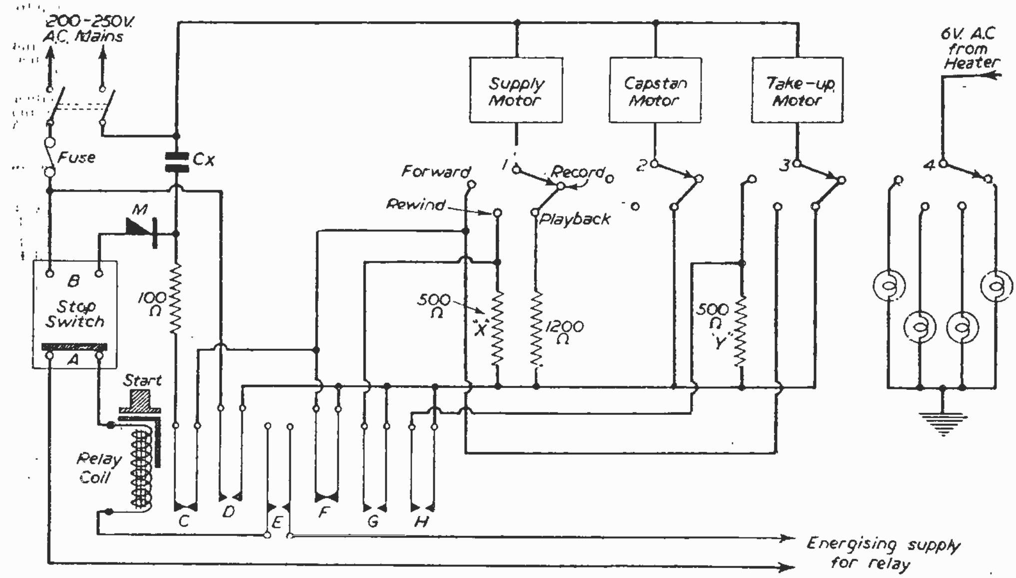
The method was tried in an experimental circuit, and after various alterations the circuit below was finally fitted. A relay was used in conjunction with the main selector switch, also a stop switch. A half-wave metal rectifier was used to supply the D.C. for the braking. The relay is actuated by pressing a button which depresses the relay trembler, or this operation can be carried out by placing a spring-loaded shorting switch across the relay contacts E. The stop operation is carried out by an Arcoelectric switch type T615B, this switch normally has one pair of contacts shorting, but when depressed these contacts open and the second pair of contacts is closed, the opening of the first pair occurring a fraction of a second before the second pair closes. This type of switch is ideal for the purpose, as it is operated by pressing a spring-loaded button. If another type of switch is used, it is essential that the operation described above takes place, otherwise D.C. will be applied before the A.C. is removed and damage to the equipment may result. If both start and stop buttons are depressed together no damage can result.

The selector switch is a four-pole, four-way, two-bank ceramic type which was obtained from an advertiser in this journal at 3s. 9d. The relay was an ex-government type and has six sets of contacts, four sets making and two breaking when the relay closes. The coil of the relay was for 12- or 6-volt operation, and as a 6-volt D.C. supply was available in the amplifier equipment this was used to energise the relay. Various types of relays are available with a coil wound for 200-250 volts, and this voltage could be obtained from the power pack as the correct requirements of this type of relay are only a few milliamperes.

Wafers 1, 2 and 3 on the selector switch control the motors, whilst No. 4 controls an indicator unit using 6.3-volt dial lamps.

Operation

As shown below the selector switch is in the Record position. When the start button is depressed relay contacts E close which completes the energising circuit and the relay holds. When the relay closes contacts D are closed and the A.C. supply is connected through to the selector switches 1, 2 and 3, and the motors energised and the mechanism starts operating. The 1,000 ohm resistor in the supply motor circuit is to supply only enough energising to maintain tape tension. When the relay is closed relay contacts C and F are open, as also are contact points B on the stop switch, so that no D.C. supply is present in the circuit. Relay contacts G and H are closed when the



Theoretical circuit of Mr. Thomson's idea.

mechanism is running; these contacts short-circuit the 500-ohm resistors X and Y. When the stop button is depressed, points A on the stop switch are opened thus breaking the relay energising circuit and the relay opens. Contacts D and E are opened and the A.C. supply to the motors removed. At the same time relay contacts C and F are closed, so changing the motor circuits over to receive the D.C. supply. A fraction of a second after the above operation has taken place, stop button contacts B are closed so applying A.C. to the metal rectifier M and the rectified D.C. is applied to the motor circuits via the current-limiting resistor R of 100 ohms, and contacts C and F, thus bringing the reels to a stop. When the stop button is released, points B are opened, removing the D.C. from the circuit and no further operation can take place until the start button is again depressed, as it requires contact points A and E to be closed before the relay is energised.

Limiting Resistors

The resistors X and Y are included to limit the D.C. energising to the motor which is pulling on fast rewind or forward wind. When the full D.C. supply was applied to both motors on a fast rewind or fast forward wind, it was found that tape sometimes spilled. By applying full D.C. to the reel from which the tape is being pulled and less D.C. to the pulling motor a much smoother action takes place, and the tape is kept taut. During normal running of the mechanism the resistors X and Y are shorted out by relay contacts G and H.

The value of the resistors in the mechanism may have to be varied from the figures quoted, depending on the types of motor employed.

The metal rectifier used was a Standard Telephones and Cables Type RM4, because this was to hand, but any half-wave metal rectifier capable of delivering 200-230 volts at approximately 100 m/A will be suitable for the circuit.

No doubt the circuit shown can be improved upon, and the interested reader may take the circuit as a basis for experiment.

Instantaneous Switching for V.H.F. Converters

By V. M. Fiske

THE practice of using separate superhet converters for receiving individual V.H.F. bands, although costly, is to be recommended, for the valves and components may then be selected to suit the required frequency, and the resultant circuit is highly efficient. Where two converters are in regular use, however, this advantage is offset by the inevitable changeover from one converter to the other, with the consequent need for power supply, and realignment, particularly when different I.F.s are used. To eliminate this procedure, the following method may be adopted to allow instantaneous switched operation of either converter.

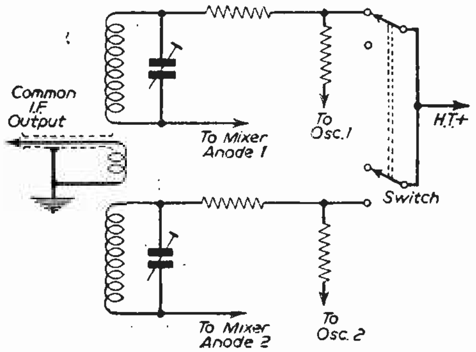
Modified Transformers

H.F. transformers consisting of two tuned windings of equal inductance may be easily modified to function as a common I.F. output transformer for two separate converters, operating on totally different signal frequencies. Such converters may conveniently be built on to one chassis.

The modification consists simply in winding an output coil equidistant between the existing windings, and arranging for the voltage supply to be connected to either converter by means of a front panel switch.

The extra coil should have the correct number of turns to suit the input impedance of the I.F. valve, and an estimation may be taken as one-quarter the number of turns on one " primary."

Theoretically, the coupling factors of the two resultant transformers are dissimilar, but in practice this may be disregarded as the advantage of having instantaneous operation of either converter far outweighs the slight reduction in output efficiency.

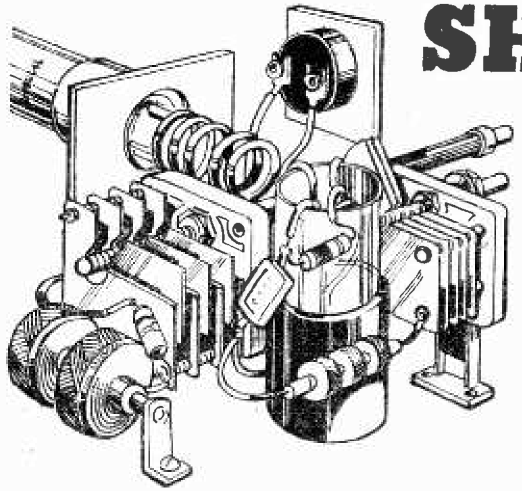


Circuit showing the switching scheme mentioned in the above notes.

Wire Coverage

Such an arrangement has been found to be very satisfactory with signal frequencies as widely separated as 40-450 Mc/s., using an I.F. of 10 Mc/s.

If desired, the heater supply may be switched simultaneously with the H.T., but in order to eliminate frequency drift as much as possible, the indicated arrangement is to be preferred. It will be obvious that where a stabilised H.T. supply is used for the oscillators, an extra switch wafer must be provided.



SHORT-WAVE SECTION

S.W. SUPERHETERODYNES AND S.W. CONVERTERS

By A. W. Mann

ALTHOUGH the high sensitivity and improved selectivity of the modern short-wave superheterodyne is appreciated generally, quite a number of enthusiasts prefer to use the T.R.F. type receivers.

Having heard a superhet in operation which was noisy so far as the background behind the signal was concerned their preference was for the T.R.F.

I am not going to suggest that superhets, be they mains or battery types, are by no means noisy. Some are noisier than others, while among commercially designed and produced models some are remarkable for the high signal-to-noise ratio.

I have, however, known instances where users of battery types such as O-V-1 and T.R.F. receivers have tried out mains and battery type superhets and claimed with justification that transmissions, unheard on the superhet, could be received on the simpler type receivers.

The reason for this state of affairs is, of course, that such signals were so weak that they were below the noise level of the more powerful and more sensitive superhet.

Unfair Comparisons

It is most unfair, however, to compare, for instance, an A.C. mains type superhet with a mains-operated T.R.F., and condemn the superhet on the score of noise level, each employing the same number of valves.

The correct procedure is to carry out tests with receivers of the respective types which are so designed and built that the outputs in terms of volume are equal. If this is done it will be found that the noise level of the one equals that of the other.

Operating Procedure

It is common practice in many instances where short-wave superhets are in use, to operate them at maximum output most of the time. While the operator has paid for R.F., I.F. and audio output controls, these are never as a rule used to full advantage. Whilst it is permissible, and an advantage, to run the R.F. stage or stages flat out if the occasion demands, a little time and thought devoted to the setting of the I.F. and audio volume controls will produce a more satisfactory signal-to-noise ratio.

I would suggest, therefore, that when listening to a short-wave superhet operated by someone else the manual volume controls should be examined and the settings should be noted.

Stress is laid on this point, because it is quite possible that a good receiver, and its designer and manufacturer, may be condemned most unfairly.

The modern superhet is capable of providing more than sufficient output to meet average requirements. Far better to demonstrate its capabilities in reproducing weak but clear signals than emphasise its roof-lifting propensities.

Early Designs

The popularity of short-wave reception had reached a high water mark several years before short-wave superhets, as distinct from the specialised communication type, were introduced in the U.S.A. Some of the earlier sponsored and commercial models incorporated up to six I.F. stages. Fixed tuning and considerable gain the easy way, with stability, were the attractions. Since then, however, it has been noted that too much I.F. amplification results in an impracticable level of noise and the general trend is to use only one or two stages.

So far as the home constructor is concerned, the most common mistake is to concentrate on a high output L.F. or audio stage for loudspeaker work. Certain amateurs, however, use home-constructed superhets for headphone reception, finishing at the second detector.

Among these are several successful DX men who find in this procedure that all the advantages of the superhet's high sensitivity and selectivity are combined with a most satisfactory signal-to-noise ratio.

This brings to mind that the R1155 receiver used as a headphone receiver in its original form, plus the addition of an audio volume control, will prove to be a most satisfactory DX proposition and is capable of being adjusted so that the noise level is extremely low.

For and Against

The availability of ex-Service receivers and equipment is regarded in some quarters as a good thing. With the aid of such equipment many who otherwise would never have done so have entered the short-wave reception field. Some carried out successful and difficult conversions. Others failed.

Stocks, however, are getting less and the time will come when the choice will be between commercially produced receivers or home-constructed ones. If the main object is listening, sponsored designs or a commercially produced receiver are indicated. If experimenting is the attraction, the more ambitious types of receivers should not be attempted until the simpler ones have been tried out.

S.W. Converters

Battery and A.C. mains type short-wave converters were at one time very popular. The amateur transmitting fraternity nowadays find them increasingly useful when additional frequency channels not covered by the station receiver are under consideration, as, for example, the V.I.F. allocations.

The writer can recall several listeners who in the past built and used the old autodyne converter, and those of the triode-pentode and triode-hexode types in conjunction with broadcast receivers, and who obtained results equal to, and, in some instances surpassing, those to be obtained with specially designed receivers, excluding the communications type.

A spell of converter construction using modern circuits, valves and methods of construction would, for instance, enable the experimenter to, as it were, iron out some of the snags peculiar to frequency changers and R.F. preselectors, before carrying the experiment further by undertaking the construction of a complete superheterodyne receiver.

As other writers have on occasion pointed out, the fundamental principle of the superhet is not difficult to understand. This, however, should not be misconstrued as meaning that superhets are simple to design and build, and that the maximum of efficiency follows automatically.

The illustration below shows an A.C. mains type converter circuit using four-volt heater A.C. valves. This in its day was a good performer, and with some modification of resistance values based on the valve manufacturers' recommendations, could be adapted to suit modern 6.3 volt heater types now so popular.

This circuit is used in the present article to illustrate the fact that short-wave converters of the triode-hexode type are by no means complicated. In addition, they offer a simple solution so far as getting started on the short waves concerns those who have an A.C. type two-band broadcast receiver, which within its scope is satisfactory.

R.F. Amplification

While there are at present in use certain commercially designed communication receivers which do not incorporate an R.F. stage, but include regenerative R.F. arrangements, the home constructor will find the extra outlay, which the addition of a pre-selector stage necessitates, well worth while in the interests of second channel effects common to non R.F. types, plus improved standards of selectivity and sensitivity.

The congested state of both short-wave broadcast and amateur bands calls for signal frequency selectivity of a high order.

It is a mistake to assume that superhet selectivity is alone dependent on the I.F. stages, other, of course, than with the degree of separation obtainable between signals adjacent to one another in frequency

Other things being equal, personal choice would lean towards a communication receiver, for instance, which incorporated two stages of R.F. preselection.

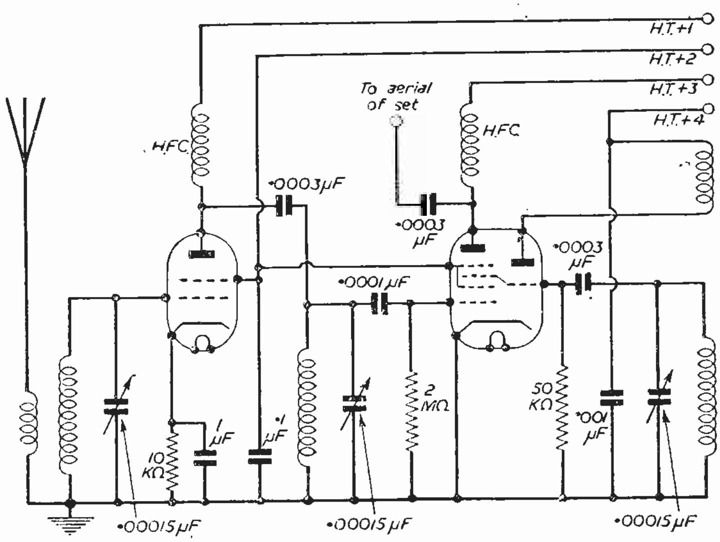
I.F. selectivity, so far as amateur communication type superhets are concerned, can be considerably improved by the use of the crystal filter or gate, or R.F. regeneration, where it is not possible to include the former. The double conversion principle, however, is deservingly gaining popularity.

From the amateur constructor's point of view all three offer problems to be solved, and considerable experience is desirable before such additions are considered.

New superhet enthusiasts should stick to tried and proved published circuits when building experimental models either of complete sets or converters. An up-to-date superhet manual, and a communications receiver counterpart, together with a few valve manufacturers' manuals, should help in the solution of various problems. Original ideas are to be deprecated at the outset, while the valve makers' advice and recommendations should be strictly adhered to.

At some future date it is the writer's intention to deal with the subject of short-wave converter construction in a more practical manner. This, however, will call for the building and testing of a number of models beforehand.

In the meantime there are several other subjects to be dealt with. It is hoped, however, that this article may clear up some of the erroneous impressions which centre around superheterodynes and superheterodyne converters.



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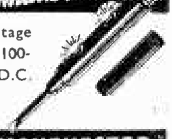

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The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

Tape Recording Experiment

SIR,—With reference to my article in PRACTICAL WIRELESS last month, on Experiments with Tape Recording, may I add the following final notes.

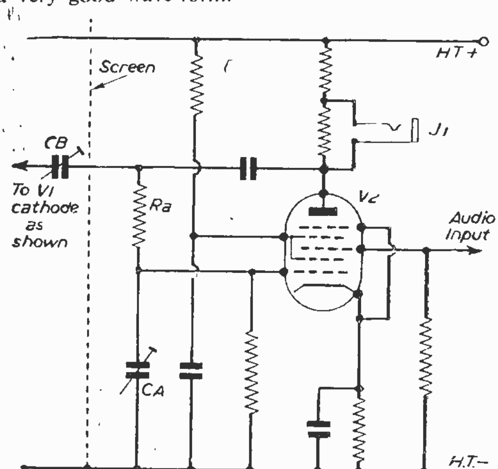
First, all main bearings and bushes are made to a strict standard on a lathe, and that the final finish is very close to not less than .0003-5 in. error on any part, that is, or requires to be made to, say .5 in. diameter, as for the capstan drive for example.

" A tolerance here must be very small regarding error, meaning that the drive could be made, say to .5005 in. at a pinch, without any real trouble occurring. It is possible to use brass bushes instead of ball-bearing races in the capstan head, if they are made to a close fit, and are also lapped to fit the spindle. Similarly, this may be applied to other parts, such as the Feed and Take-up reel spindles.

It is not essential to stick to the standard tape velocity of $7\frac{1}{2}$ ins. per second, but that any speed consistent with good intelligible quality, such as 5 in. per second or 10 in. per second, can be used.

As for the bias and erase supply, good results can be obtained by a simple straightforward circuit using a single valve, a pentode. This arrangement, utilising a ready-made coil costing about 10/-, plus the valve, can, if used at the lowest possible screen voltage to obtain feed-back or oscillation, provide a very good wave-form.

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of cover.



The revised circuit suggested by Mr. Hope.

If these simple details are followed out, then in most cases, anybody performing recording will get good results with their equipment.—Z. M. E. PREECE (Hayes).

The Principles of N.F.B.M.

SIR,—I must apologise for the errors appearing in my circuit diagram on page 518, of the November issue of PRACTICAL WIRELESS. The reactance modulator, V_2, should be wired up as shown in the diagram below.—WM. A. HOPE (Roxburghshire).

Electronic Organs

SIR,—Congratulations on your Electronic Organ article. I am glad that PRACTICAL WIRELESS has had the courage to tackle this much neglected branch of electronics.

Don't let it stop at this simple monophonic instrument—let's have more articles on the subject, and details of polyphonic instrument construction.

I have been experimenting for some time with polyphonic systems and would be glad to contact anyone with a similar interest.—K. STUART BAILEY (Manchester).

Design of the Output Stage

SIR,—As a beginner to the field of radio, the article in September issue was very interesting, and filled in some of the points that have puzzled me. There is, however, a section of the article that stumps me. You state

$$C=\frac{10^5}{2\pi fz}=\frac{10^6}{6.28\times 100\times 15}$$

Now I know $2\pi=6.28$, and $f=100$, and $z=15$. But where did you get 15 from? In the previous sentence you state " take the value of the cathode resistor and calculate the value of condenser, which will give an impedence of one-fifth this value." I take it you mean the resistor 150 Ω, one fifth of which is 30 Ω not 15 Ω. Also why only use one-fifth ?

I would be very pleased if you would solve this problem for me.—C. D. STEWART (Weston-s-Mare).

[*There is, as you have noticed, an error in the calculations ; the 15 should have been 30. The reason that the one-fifth is used, is because above this value the attenuation in the circuit is increased by the negative feedback introduced.—J. S. K.*]

Balanced Speakers

SIR,—I am sorry that Mr. Cowton does not like my tone control, or pressure units in general.

Pressure units used intelligently are the basis of good reproduction, and do not need to be run at high volume level, any more than ordinary units.

Next, cross-over networks are not cumbersome or costly. I have made my own unit "Half Section, Parallel Constant Resistance" from ex. Government material for less than 10/-, size 10in. × 4in. × 4in.

Lastly, there is no earthly need for a separate speaker for the middle frequencies—the low or bass reproducer will handle these quite easily.

However, I wish him luck with the most complicated hook-up I have ever heard of, and hope he gets as much enjoyment out of it as I do from mine.—A. WATERWORTH (Burnley).

"The Mini-Four"

SIR,—Thank you for your reply to my Mini-Four query. I checked the connections in the first stage as you advised and found that I had connected condenser CH on the earth side of CI.

I am very pleased to say that I now have the set working properly, and I must say that I am more than pleased with the results I get, especially as this is the first receiver I have ever built.

I wish to thank you very much indeed for your help and advice.—D. HARDING (Salisbury).

Binaural Listening

SIR,—In reading the radio show review by the Marquis of Donegall, I was surprised to find that he had been completely dazzled by TV and made no mention of what was surely the most interesting demonstration of the show, namely the G.E.C.'s Three Dimensional Sound.

I felt that this alone relieved the tedium of an exhibition that had little interest to the experimenter.

For listening to orchestras and certain other entertainment, binaural listening is so much more realistic that I suggest the BBC could readily provide a binaural service for London by the use of a low-power F.M. transmitter at some such place as Alexandra Palace to work in conjunction with Wrotham.

I am convinced that there are many high fidelity seekers in the London area who would willingly invest in a second channel.

In my opinion the development of amplifiers, speakers and acoustic systems is reaching finality, and that only by the binaural system can a noticeable improvement be made in high fidelity sound reproduction.—EDWARD H. BALL (South Harrow).

Using a Signal Generator

SIR,—Re "Calibrating a Home-built Signal Generator," by Angus D. Taylor, in December's PRACTICAL WIRELESS. Mr. Taylor describes the procedure very clearly except for one important thing, and that is the coupling between generator and receiver when carrying out the first part of the calibration. A screened lead should be taken from the generator and the end couple of inches or so of the core placed near the receiver aerial down lead so that only a small capacitive coupling is obtained.

When calibrating the 300 to 500 kc/s range as described by Mr. Taylor, it is best to disconnect the receiver aerial and loosely couple the generator output into the aerial socket so that only the generator output will be heard and thus reduce the likelihood of hearing unwanted heterodynes, resulting in incorrect calibration.—R. A. POOL (Newark).

Centre-loaded Aerials

(*Continued from page 38*)

Again, the value of centre-loading lies in cases where it is impossible to erect a full half-wave aerial, as by centre-loading a more efficient utilisation of the length of wire it is possible to put in a restricted space is achieved. For this reason, an amateur with a modest 30ft. or so of garden space could erect a centre-fed aerial of the type shown in Fig. 5, and even if the adjustment of the loading coils took some time in order to hit the optimum conditions, the results would be well worth while. As shown, each loading coil is made the same, so that the centre-fed system is kept in a balanced condition. In fact, the term "centre-loaded" should be interpreted as the centre loading of each element of a radiating system. Fig. 5 can be regarded as a conventional half-wave centre-fed aerial, with loading coils inserted in each of the sections.

If one is prepared to wind some 40-odd feet of wire into each loading coil, then the short top of some 30ft. can be loaded up to become an aerial resonant upon 80 metres.

An Intermittent-fault Finder

(*Continued from page 12*)

than likely be at zero. The input controls should be set to maximum, of course, initially. It is best to bring the L.F. indicators in line with those of the H.F. by decreasing the inputs with the appropriate controls.

Looking at Fig. 2 we see the input grid is not used by a test lead. This is because the signal here is weak and also that if a set fails to operate and all the indicators return to the number one position, the fault, provided the D.C. side of the set is working as normal, must then be either in the input circuit, valve, or the immediate components following the valve.

The fault mentioned earlier, where it was stated that a broadcast signal might be difficult to use is when a set is being tested for intermittent falls in volume, when it will be clearly seen that the L.F. indicators should give a set reading.

Finally, no measurements are given; the author used the instrument with a separate P.U. which has to supply several other pieces of test gear.

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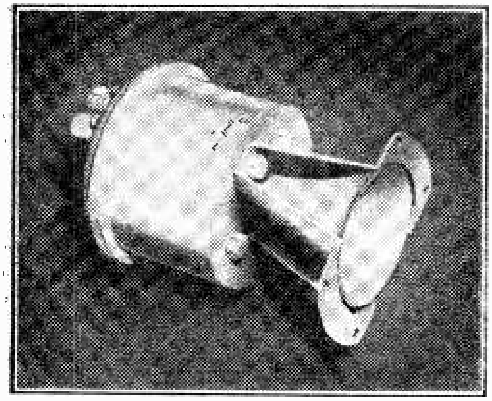
TRADE NOTES

The Stentorian Pressure Type Tweeter Unit

WHITELEY ELECTRICAL announce a new Quality reproduction aid in the form of an H.F. Tweeter.

The Unit is of the moving coil pressure type and is similar to that embodied in the 10 in. and 12 in. Concentric Duplex Loudspeakers. The speech coil is of aluminium wire, wound on an aluminium former which is rigidly fixed to an aluminium diaphragm. The speech coil and diaphragm is situated at the rear of the magnet and the centre pole hollowed out to form the commencement of the Horn, in the centre of which is located the phase equaliser. The Unit may be used with any cone speaker, providing high quality at low cost.



The W/B Tweeter Unit.

Speech coil impedance: 15 or 30 ohms.
Flux density: 14,000 gauss.
Response: 2,000/14,000 c.p.s.
Power handling capacity: 3 watts.

It is recommended that a suitable cross-over network of between 2,000/3,000 c.p.s. be used. Retail price, 75s. 6d.—**Whiteley Electrical Radio Co., Ltd., Victoria Street, Mansfield, Notts.**

EKCO Price Announcement

THE EKCO CR181/F, a six-valve superhet car radio styled for installation in the latest design facias of the Ford Consul and Zephyr-Six models, which was announced last month by E. K. Cole, Ltd., is priced at £33 tax paid. (Basic price £23 0s. 5d. Purchase Tax, £9 19s. 7d.)

Improved Geiger Müller Tube

LONGER life, larger pulse amplitude and lower operating voltage are the outstanding characteristics of the new Geiger Müller tubes designed by The General Electric Co., Ltd.

The new tubes have been manufactured on a pre-production scale and are obtainable at short notice. Similar in size and window weight to the existing GM.4 tube, and with an operating voltage of about 450 v., the 25B7H uses a bromine quenching agent and is known as a halogen quenched type.

Other types of halogen quenched GM tubes will be available later.—**General Electric Co., Ltd., Magnet House, Kingsway, W.C.2.**

Barker Speakers

AS a result of the recent imposition of Purchase Tax AADU are now supplying the Barker Units directly to customers, thus enabling basic prices to be reduced.

Model 148a is now £11 10s., plus £5 7s. 4d. P.T.; the 150 is £14, plus £6 10s. 8d. P.T.; and Model 501 Cabinet, which is now only sold separately, is £19 ex works.—**AADU (Barker Natural Reproducers), 3, Newman Yard, W.1.**

New Mullard Tuning Indicator

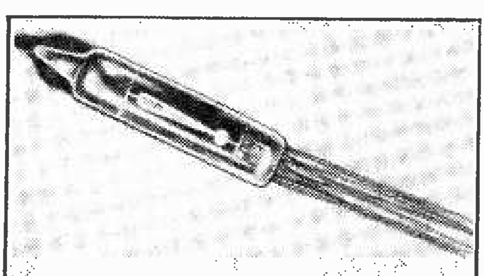
A NEW development, recently announced by the Entertainment Valve Department of Mullard, Ltd., is the DM70 Tuning Indicator. Not only does this tube provide, for the first time, simple and efficient visual tuning for all-dry-battery receivers, but it is also an inexpensive alternative to the conventional type of "magic eye" indicator in A.C. mains-operated equipments.

Of subminiature construction, this new indicator occupies minimum space, the viewing area being only $\frac{3}{4}$in. by $\frac{1}{4}$in. It can be mounted in any position, allowing it to be used either behind a glass window or as the moving cursor of the tuning dial.

The indicator is of triode construction, in which the control electrode or "grid" is a metal plate with an aperture shaped like an exclamation mark. This gives the tube a variable-mu characteristic. The anode, which is coated with a fluorescent material, is viewed through the grid aperture from the filament side. The filament consists of a single thin wire having a low operating temperature.

The optimum control curve is obtained when, with an anode voltage of 60 v., pin 5 of the tube base is connected to the negative terminal of the filament supply. With an anode voltage of 90 v., it is necessary to connect pin 5 to the positive end of the filament supply.

The operation of this new tuning indicator is basically as follows: with zero grid voltage, electrons are drawn from the cathode through the whole length of the grid aperture. As the potential on the grid goes negative, the electron flow—and hence the fluorescence—in the narrowest part of the aperture ceases. As the grid goes still more negative, the fluorescent pattern is restricted to the top and bottom of the aperture until finally, at cut-off point, the tube is completely dark.—**Mullard Ltd., Century House, Shaftesbury Avenue, W.C.2.**



The new Mullard Tuning Indicator.

BOOKS

PERSONAL RECEIVERS. A new book just out. The author is Mr. E. N. Bradley who is a well-known writer on this subject. His book deals progressively with the design, construction and detailed alignment of all modern receivers in the portable and personal class. It shows how the constructor may either design his own set or improve the performance of an existing set. Published at 3/6 by NORMAN PRICE (PUBLISHERS), LTD., 283, City Rd. London, E.C.1.

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PRACTICAL WIRELESS, Jan., 1953

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